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GAS ENGINE FOR ICE MAKING

Low Attendance and Fuel Costs With Natural Gas as Fuel

DURING THE PAST FEW years great strides have been made in the development of the gas engine and its application to industries requiring cheap and reliable power, so that today there are few lines in which the modern high-class gas power plant is not in satisfactory operation.

Economy of fuel has always been one of the strongest recommendations of the gas engine, especially where gas was abundant and low in cost. Improved design and higher engine compression have greatly increased efficiency, however, and the advent of the producer gas engine, in which the gas is generated direct from coal has broadened the field for this economical power.

Increased economy, however, counts for little unless absolute reliability is assured, and it is in this respect that the modern gas engine is obtaining an enviable record, many installations operating continuously 24 hr. a day and 7 days a week.

This reliability has been brought about by several important improvements in design: Such engines usually have 2 or more cylinders with all similar parts interchangeable, so that one cylinder may be completely cut out for adjustment without affecting the operating of the plant; a reliable and positive system of ignition has been developed, in which the current is generally obtained from 2 independent sources; simplicity and accessibility in every part allow alteration and adjustment while the plant is running.

Installations in various branches of manufacture and especially in refrigerating plants the past few years, have demonstrated that a high-grade gas power plant, properly installed, is entirely reliable and quiet in operation, and has excellent economy. A typical example may be found in a gas engine driven plant of the Walton Ice Co., Elyria, Ohio. The capacity of the plant is 12 tons of ice in 24 hr. with a storage refrigeration equal to 6 tons refrigeration or 3 tons of ice extra.

The plant is operated with a 40-hp. natural gas engine, made by the Elyria Gas Power Co., belted through countershaft to a horizontal double acting ammonia compressor, 9-in. bore and 16-in. stroke, running about 70 r.p.m. The high pressure side of the plant is of standard

FIG. I. VIEWS OF COMPRESSOR AND ENGINE INSTALLATION

size and dimensions, all furnished by the Cleveland Ice Machine Co. The ice freezing tank is 27 ft. long, 18 ft. 6 in. wide and 4 ft. deep and contains 165 300-lb. ice cans. The ice storage room of 12,000 cu. ft. capacity, is capable of holding 300 tons of ice.

Producing clear ice from raw water taken direct into the cans from the city mains is accomplished with a volume blower forcing in air through pipes submerged in the cans, thereby keeping the water in agitation until the cake is frozen. The pipes are, however, withdrawn when

The complete cost of making ice in this plant is interesting. Two men are employed as operators, each on a 12-hr. shift, with a total labor charge for a 24-hr. day of $4.50. These men not only pull the ice at proper intervals, but give necessary attention to the machinery.

About 10,000 cu. ft. of natural gas is used as fuel each 24 hr. at cost of 30 cents per thousand or $3 a day, including both gas for engine and light at night in machine and tank room.

The engine, compressor, transmission, etc., require

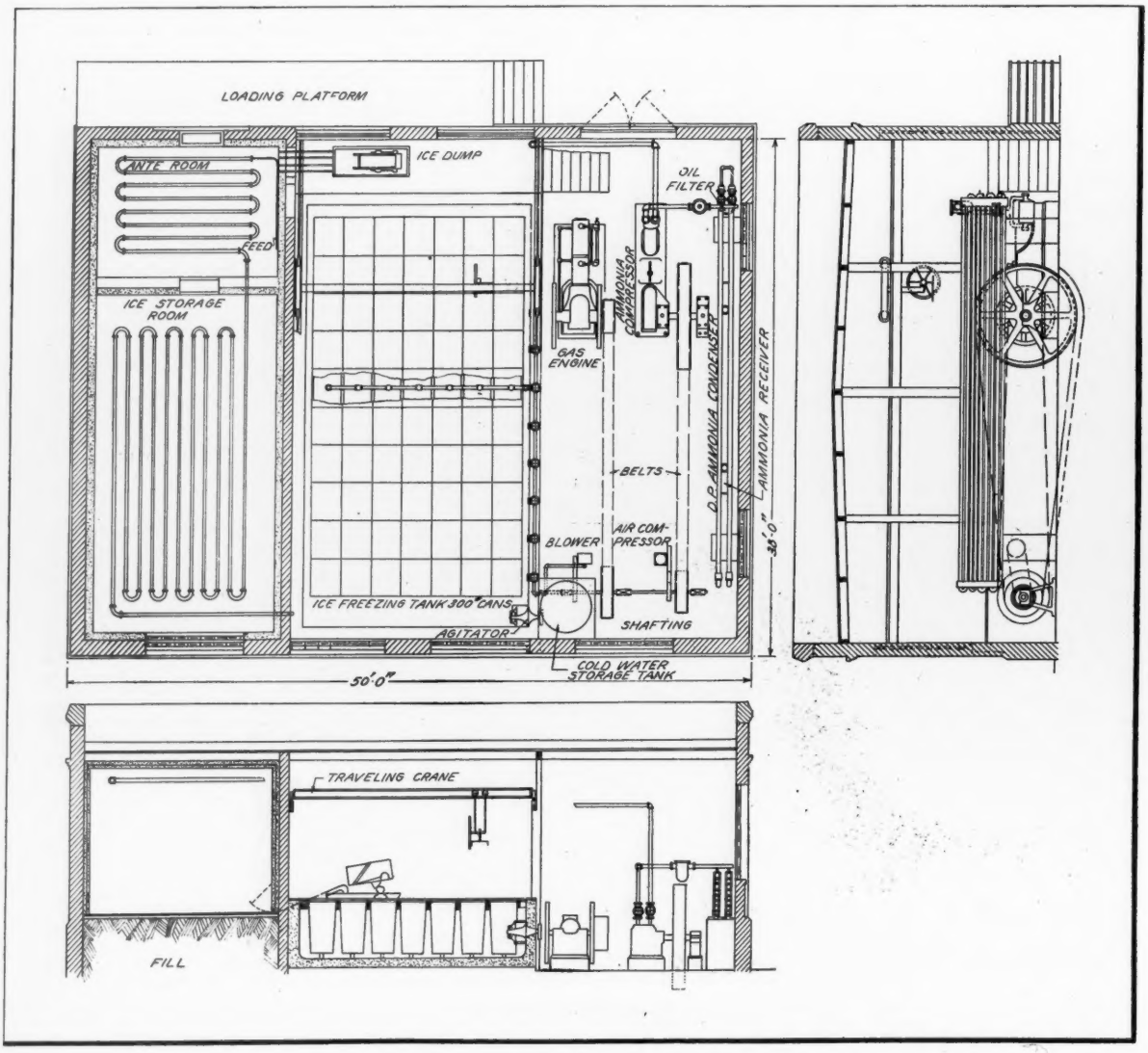


FIG. 2. PLAN AND ELEVATION SHOWING ARRANGEMENT OF MACHINERY IN WALTON ICE PLANT

the ice is frozen to within 18 in. of the top of the can, which leaves a small pocket of ice which will be opaque, in most cases about 3 in. wide, 6 in. long and 12 in. deep. This, however, can be obviated by taking the trouble to withdraw this water or core before being frozen and replacing with fresh water.

This particular plant has been visited by a great many refrigerating engineers and representatives of ice companies, who state that the ice is the clearest that has ever been produced with methods of somewhat similar construction.

one gallon of 35-cent oil per 24 hr., hence 50 cents would safely cover oil, waste and incidentals. The water used for the ice and in the condenser, amounts to about $2 a day.

The entire cost for operation expenses during 24 hours is as follows:

Labor	$ 4.50
Gas	3.00
Lubricants	.50
Water	2.00
Total	$10.00

If this is figured against the rating of 12 tons ice output, the average cost would be about 85 cents per ton of ice "pulled." But according to the actual facts in the matter, 13 tons of ice is produced and with the refrigeration load, the total equivalent would be 16 tons. That is, considered from a power standpoint of view, the work done is equivalent to that in a 16-ton plant for ice purposes only, so that the cost would be below 55 cents a ton.

It is also interesting to note the fuel economy of this plant. To operate the compressor, ammonia and brine pumps, with the transmission employed in this plant requires a minimum of 37 hp. under average conditions, and allowing 10,000 cu. ft. of gas for 24 hr. consumption shows that this plant is developing a horsepower-hour on 11.3 ft. of gas with a rated 40-hp. engine, operating in the hands of inexperienced engineers and over a continuous run of 7 days.

City water is first taken through a fore cooler supplied with brine coils, and then to the cans direct. Cooling water for the condenser coils comes from the city mains, passes through the pipe condenser and thence to the jacketing of the engine cylinder and to sewer, so that this water is included in the cost stated.

Ammonia pressures carried are 17 lb. on the low side and 155 lb. on the high, and the first charge of 1200 lb. of ammonia has had no renewal or addition during the year that the plant has been in service.

The engine is equipped with the modern accessories, including a 2-feed Phoenix lubricator and Hercules belted magneto, and care is taken to keep down cost of oil and supplies, the amount used being 1 gal. of cylinder oil, and 1 gal. of new and 2 gal. of filtered engine oil in a 24-hr. run. Starting of the engine is accomplished by compressed air at 175 lb. pressure from a storage tank to which air is supplied by a compressor belted from the jack shaft, the pressure being pumped up once a day.

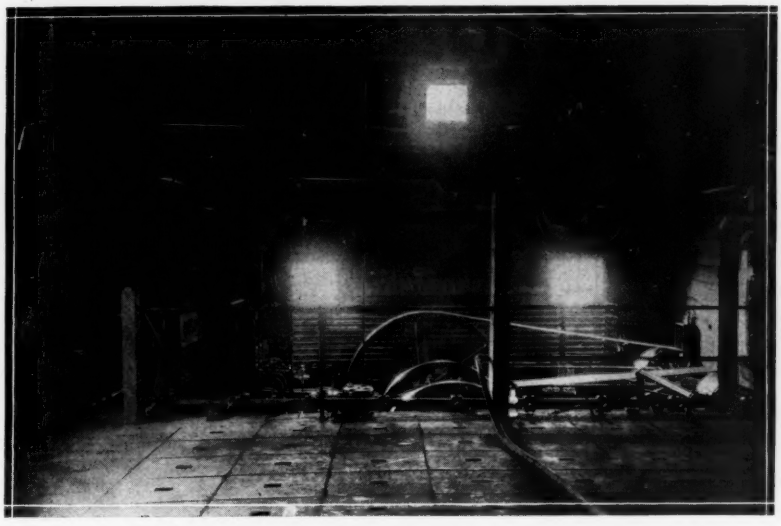


FIG. 3. VIEW SHOWING FREEZING TANK AND RELATION TO MACHINE ROOM

FIG. 4. OIL TRAP, GAGE BOARD AND COMPRESSOR PIPING

MOST MEN who retire from the harness before they die have made exceptionally good or just the reverse.

A man's work, in any occupation, involves his heart, his head and his hands.

FAN VS. CHIMNEY

COMPARED with a stack or chimney, the fan shows remarkable superiority for producing air movement. The relative efficiency of a fan and a stack or chimney, under ordinary working atmospheric conditions is shown in the accompanying table.

Even at ordinary speed, a fan produces a pressure difference so much in excess of that created by a heated stack that far larger volumes may be moved at increased velocity. With internal air as high as 200 degrees and outdoor air at 50 degrees a stack would have to be nearly 600 feet high to produce the same pressure as is created by a fan at ordinary speed.

The importance of ample air circulation in the drying process is recognized by all. March has always been considered one of the best months for drying. With the stack it is evident that circulation can be secured only by actual waste of heat to the atmosphere, for it is the temperature of the escaping air that governs the velocity; hence there is a twofold increase in the waste; the air is both greater in volume and higher in temperature. With the fan, on the other hand, additional air volume costs practically nothing, for all the steam required to operate the fan engine is utilized in the heater and to this extent reduces the amount necessary to be supplied from any other source. The temperature of escaping air from the room may still be maintained as before.

RELATIVE EFFICIENCY OF A FAN AND STACK

HEIGHT OF STACK IN FEET	NUMBER OF TIMES FAN IS MORE EFFICIENT THAN STACK	
	WHERE FAN ENGINE EXHAUST IS WASTED	WHERE FAN ENGINE EXHAUST IS UTILIZED
30	20	350
40	15	260
50	12	210
60	10	175

IT IS POSSIBLE to understand why a man will take the trouble to have his concrete blocks made to imitate granite. And why he should go to the expense of having his galvanized iron covering made to imitate concrete block imitation of granite. But why—oh why—does he go to all this trouble and then paint the iron "masonry" sky blue or vile green?

UNIFORM BOILER SPECIFICATIONS

Abstract and Discussion of the Report of the Committee of the American Boiler Manufacturers' Association

AT THE BEGINNING of its report, the committee gave an outline of the action of the A. B. M. A. in previous years as regards uniform boiler specifications. They showed that as first passed these were a fair compromise between the ideas of the boiler manufacturers and of the steel manufacturers and that, for the time being, they gave satisfaction to both parties. They showed, however, that committees on getting these laws passed were not successful, due partly to the opposition of manufacturers engaged in the production of small boilers, such manufacturers not wishing to be restricted as to the material that they should use. The final uniform specifications were discussed, amended and adopted in 1898 and were afterwards somewhat modified in 1905 and 1909. It was, however, considered inadvisable to attempt to have these specifications adopted into laws by the various states as it was thought that an educational campaign would have more permanent effect and in any case would be necessary before the passage of such laws could be secured.

In the work of the Massachusetts Board of Boiler Rules, many of the practical conclusions of the A. B. M. A. were embodied and in the discussion at the meeting in 1909 a general endorsement of the Massachusetts rules was adopted. This endorsement has been misunderstood and sometimes misrepresented as pledging the A. B. M. A. to every detail of the Massachusetts rules; whereas the association has and always will reserve the right and maintain its duty to work for further improvement and advancement where the practical working of any law or rules indicates the necessity for it.

At Boston last year request was made of the manufacturers in Massachusetts to formulate suggestions for modifications of these rules which were considered necessary and various reports were laid before the Committee on Uniform Rules at the recent convention in New Orleans. In the report made to the latter convention, special attention was therefore given to the Massachusetts rules and changes and amendments were suggested to bring these into harmony with the ideas of the boiler manufacturers.

Heating Boilers

TAKING up the report in detail, in Part 2 the Massachusetts rules allow 25 lb. pressure if the boiler is constructed wholly of cast iron. The manufacturers recommend that this be reduced to 15 lb. and that such boilers be used only for heating purposes. This seems a reasonable recommendation in view of the well known variation in strength of castings and the liability to uneven thickness in castings. Furthermore, in present day practice, few if any boilers which are designed to carry more than 15 lb. pressure are constructed wholly of cast iron, and no hardship would be worked to manufacturers or to users by such a rule.

The committee considers that heating boilers built entirely of steel should be allowed a pressure not exceeding 25 lb. per sq. in. This seems a bit ambiguous as it is entirely possible that a boiler might be built for heating only and yet be so designed and constructed as to be perfectly capable of carrying 150 lb. per sq. in., this pressure being reduced to lower pressures for industrial purposes and for heating as might be required in the installation.

Rivet Stress

VALUES allowed for crushing strength of mild steel at 95,000 lb. per sq. in. of cross sectional area and shearing strength of rivets at 38,000 lb. per sq. in. of sectional area for iron rivets in single shear, 70,000 lb. for iron rivets in double shear, 42,000 lb. for steel rivets in single shear and 78,000 lb. for steel rivets in double shear were accepted as being satisfactory, as was also the table given in paragraph 6 of the Massachusetts rules for the shearing strength of rivets.

The Manufacturers' committee disagreed with the provision of the Massachusetts rule that the allowable factor of safety be based on the years of service of the boiler and holds that such factor of safety should be based on the actual physical condition of the boiler at the time of inspection. This would seem to be good common sense, as it is quite possible that one boiler which has been in service 10 yr. under moderate load and careful operation, will be in much better condition than another which has been used only 5 yr. and has been driven hard and neglected.

Safety Valves

SECTION 2 of Part 2 in the Mass. rules relates to the subject of safety valves, the Manufacturers' committee makes no comment as to the safety valve area provided. The Mass. rules state that the area of a direct spring loaded safety valve in square inches shall be equal to the (pounds of water evaporated per sq. ft. of grate surface per second) $\times$ 770 $\div$ (the absolute pressure which the safety valve is set to blow $\times$ the grate surface in square feet). From this, a table of allowable grate surface in square feet for spring loaded safety valves is deduced as shown in the data sheets of this issue.

The Manufacturers' committee disagrees with the provision of the Mass. rules which prohibits cast-iron seats for safety valves; as universal satisfactory experience on the navigable waters of the inland rivers with lever safety valves having cast-iron seats seems to prove that such seats are safe and satisfactory.

The committee also disagrees with paragraph 9 of the Mass. rules which signifies that the bearing surface of safety valves must have an angle of 45 deg. This disagreement is based on the experience of reputable manufacturers of standard safety valves who use the flat seat and whose poppet safety valves are found to be equally safe and effective with those having a 45-deg. seat.

Accessories and Hydrostatic Test

REQUIREMENT of the filling of fusible plugs with pure tin is concurred in but the Manufacturers' committee holds that the maximum diameter of the fusible metal should never exceed ⅜ in. under any conditions, whereas the Mass. rules allow a diameter of ½ in. or over where the working pressure is less than

175 lb. Other provisions of the rules in regard to the location of the fusible plug, provision for boiler accessories, such as the water gauge glass, the gauge cocks, feed pipes, stop valves, etc., are concurred in, but section 6 of the Mass. rules relating to the hydrostatic test which provides for a hydrostatic pressure 1½ times the maximum allowable working pressure except that for boilers where 25 lb. pressure is to be carried the hydrostatic test may be twice the working pressure is considered inadvisable; and in place of this it is recommended that the hydrostatic pressure used be not more than 1⅓ times the working pressure and the excess above working pressure be limited to 100 lb. per sq. in., water used for testing to have a temperature of at least 125 deg. F.

It is not quite clear why the 1½ times working pressure should be considered injurious for ordinary pressures up to 200 lb. per sq. in. For boilers carrying higher pressures than this, as for instance 300 lb., it is evident that a test pressure of 450 lb. might be undesirable, but that a boiler to carry 100 lb. should not be tested to 150 lb. rather than 130 does not appear reasonable, although as the object of the hydraulic test is usually to determine leakage, there does not, on the other hand, seem to be any particular reason for desiring a test of more than 1⅓ times the working pressure.

Provision for using warm water for this test is good, as the annual hydraulic test is likely to be made when the boiler is hot and the use of cold water will produce contraction strains that are undesirable if not dangerous.

Other provisions of Part 2 relate to the method of computing the efficiency of a riveted joint, a matter of mathematical computation, and are therefore concurred in by the committee.

Part 3 of the Mass. rules relates to boilers installed after May 1908, and the first section has to do with the materials used in boiler construction. It defines chemical properties and names of grades of steel with the required tensile strength, elongation and chemical composition for each grade. In place of this the Manufacturers' committee recommends the substitution of the former uniform specifications of the A. B. M. A. in regard to materials, which are as follows:

Materials

CAST IRON should be of soft, gray texture and high degree of ductility. To be used for hand-hole plates, crabs, yokes, etc., and manheads. It is a dangerous metal to be used in mud drums, legs, necks, headers, manhole rings or any part of a boiler subject to tensile strains; its use is prohibited for such parts.

Steel. Homogeneous steel made by the open hearth or crucible processes, and having the following qualities, is to be used in all boilers.

	Tensile Stress Pounds.
Flange or Boiler Steel	55000 to 65000

"When it is stipulated that the plates are to be flanged, the physical properties shall be the same as required for Fire Box Steel."

	Tensile Stress Pounds.
Fire Box Steel	52000 to 62000
Extra Soft Steel	45000 to 55000

	Elongation in 8 inches.
Flange or Boiler Steel	25%
Fire Box Steel	26%
Extra Soft Steel	28%

	Chemical Requirements Sulphur	Phosphorus
Flange or Boiler Steel	.03%	.04%
Fire Box Steel	.03%	.04%
Extra Soft Steel	.03%	.04%

For all plates the elastic limit to be at least one-half the ultimate strength; percentage of manganese and carbon left to the judgment of the steel maker.

Test Section to be 8 in. long, planed or milled edges; cross sectional area not less than ½ of 1 sq. in., nor width less than the thickness of the plate.

Bending Test. Steel up to ½ in. thickness must stand bending double and being hammered down on itself. Above that thickness it must bend round a mandrel of diameter of 1½ times the thickness of plate down to 180 deg. All without showing signs of distress.

Bending test piece to be in length not less than 16 times thickness of plate, and rough, shear edges milled or filed off. Such pieces to be cut both lengthwise and crosswise of the plate.

All tests to be made at the steel mill. Three pulling tests and 3 bending tests to be made from each heat. If one fails the manufacturer may furnish and test a fourth piece, but if 2 fail the entire heat to be rejected.

Certified copies of tests to be furnished each member of A. B. M. A. from heats from which his plates are made.

Rivets to be of good charcoal iron, or of soft, mild steel, having the same physical and chemical properties as the fire box plates, and must test hot and cold by driving down on an anvil with the head in a die; by nicking and bending, by bending back on themselves cold, without developing cracks or flaws.

Boiler tubes, of charcoal iron or mild steel specially made for the purpose, and lap welded or drawn; they should be round, straight, free from scales, blisters and mechanical defects, each tested to 500 lb. internal hydrostatic pressure.

This fact and manufacturers' name to be plainly stenciled on each tube.

Standard Thicknesses by Birmingham wire gauge to be:

No. 13 for tubes 1 in., 1¼ in., 1½ in. and 1¾ in. diameter.

No 12 for tubes 2 in., 2¼ in., and 2½ in. diameter.

No. 11 for tubes 2¾ in., 3 in., 3¼ in., and 3½ in. diameter.

No. 10 for tubes 3¾ in., and 4 in. diameter.

No. 9 for tubes 4½ in., and 5 in. diameter.

Tests. A section cut from one tube taken at random from a lot of 150 or less must stand hammering down cold vertically without cracking or splitting when down solid.

Length of test pieces:

¾ in. for tubes from 1 in. to 1¾ in. diameter.
1 in. for tubes from 2 in. to 2½ in. diameter.
1¼ in. for tubes from 2¾ to 3¼ in. diameter.
1½ in. for tubes from 3½ in. to 4 in. diameter.
1¾ in. for tubes from 4½ in. to 5 in. diameter.

All tubes must stand expanding over on tube plate and bending without flaw, crack or opening of the weld.

Stay bolts to be made of iron or mild steel specially manufactured for the purpose, and must show on:

Test Section 8 in. long net:

For Iron, tensile strength not less than 46,000 lb.; elastic limit not less than 26,000 lb.; elongation not less than 22 per cent. for bolts of less than 1 sq. in.

area, nor less than 20 per cent. for bolts 1 sq. in. and more in net area.

For Steel, tensile strength not less than 55,000 lb.; elastic limit not less than 33,000 lb.; elongation not less than 25 per cent for bolts of less than 1 sq. in. area, nor less than 22 per cent for bolts 1 sq. in. and more in net area.

Tests. A bar taken from a lot of 1,000 lb. or less at random, threaded with a sharp die V thread with rounded edges, must bend cold 180 deg. around a bar of same diameter without showing any crack or flaws.

Another piece, similarly chosen, and threaded, to be screwed into well fitting nuts formed of pieces of the plates to be stayed, and riveted over so as to form an exact counterpart of the bolt in the finished structure; to be pulled in testing machine and breaking stress noted; if it fails by pulling apart the tensile stress per square inch of net section is its measure of strength; if it fails by shearing the shear stress per square inch of mean section in shear is this measure. The mean section in shear is the product of half the thickness of the plate by the circumference at half height of thread.

Braces and Stays. Material to be fully equal to stay bolt stock, and tensile strength to be determined by testing a bar not less than 10 in. long from each lot of 1000 lb. or less.

In regard to variation and weight the Manufacturers' committee recommends the omission of a table of allowances of overweight and the substitution of the rule that "Plates will be considered up to gage if measuring not over 1/100 in. less than the ordered gage." There is, however, no disagreement with the specifications of the Massachusetts rules in regard to the variation in weight nor in regard to the matter of finish and stamping of plate and heads by the plate manufacturer.

In regard to section 2 on the subject of material to be used, the manufacturers recommend that designations such as "flange," "fire box," "open hearth," be eliminated and that the qualities of the plate as ascertained by actual test be conclusive in defining the material to be used. They recommend also that cast iron be not allowed in the use of drums of water-tube boilers under any conditions, although the Massachusetts rules permitted the use of cast iron for pressures less than 160 lb. per sq. in.

Lap Joint

AN important part in which the manufacturers disagree with the Massachusetts rules is that of the lap joint type of construction. The Massachusetts rules do not allow a lap riveted joint in a shell or drum which exceeds 36 in. diameter and for a shell or drum of less diameter than this which is lap riveted a maximum pressure of 100 lb. only is allowed. The Manufacturers' committee states that this limitation is not warranted by the experience of reputable boiler manufacturers. Lap riveted boilers of 48 in. in diameter have been and are in successful use on the Mississippi River and its tributaries at pressures up to 200 lb. and though a state law would not govern the construction of boilers for such steamers, the practice in most cities and towns located on these waters naturally follows the satisfactory practice of the steamboats in that section. This would indicate that the manufacturers believe that lap riveted construction should be allowed in boilers up to 48 in. in diameter and for pressures up to 200 lb. per sq. in.

The manufactures further believe that the rule of the Massachusetts board which specifies that all plates in a shell or drum shall be of the same gage should be modified to permit the manufacturer to use plates in one part somewhat thicker than those in another part so long as the plates are of sufficient gage to meet the requirements of the rules as to tensile strength.

Bumped Heads

IN order to avoid a misunderstanding, recommendation is made that when speaking of bumped heads, the terms externally convex and externally concave being used to determine whether the curvature is outward and inward. In the Massachusetts rules as thus modified the minimum thickness of an externally convex head is determined by the rule that the thickness equals one-half the radius to which the head is bumped multiplied by the factor 5 and by the working pressure in pounds per square inch, for which the boiler is designed, and divided by the tensile strength in pounds per square inch of the plate from which the head is made. For externally concave heads the same rule applies, except that the quantity is to be again divided by the constant 0.6. The manufacturers recommend that this constant be changed to 0.8 as has been proved advisable by the experience of the steamboat inspection service. The combining of 2 paragraphs relating to convex and concave heads was recommended so that the statement would be that a convex or concave head having a manhole opening should have the flanges of the opening turned inward to a depth not less than 3 times the thickness of the head, which thickness must be increased above that found by the previous rules by not less than ⅛ in.

Staying

IN the matter of staying, the Manufacturers' committee recommends that the minimum thickness of plates be limited to 5/16 in. in all stayed surfaces whether flat or curved. In the following paragraph the Massachusetts rules give the pitch allowed for stay bolts on a flat surface and on the furnace sheet of an internally fired boiler where the external sheet of the furnace is over 38 in., except in case of a corrugated furnace; the table of the maximum allowable pitch is given in the data sheet of this issue.

Provision is made that when the maximum allowable pitch is 5½ in. or less, stay bolts adjacent to a furnace door or other boiler fitting may have an increased pitch of not over 1 in. The Manufacturers' committee recommends that this increased pitch be allowed not over 1½ in. but in one direction only. This would give a more convenient arrangement of stay bolts under certain conditions met in the construction of furnaces. The committee also recommends that for small steel heating boilers limited to 25 lb. pressure and under no stays be required; this should of course be taken in connection with a previous rule not mentioned that in the construction of a boiler no plate less than ¼ in. thick shall be used.

It is also recommended that in the interest of clearness the statement should be made that the "pitch of stay bolts shall be measured on the inside of the furnace."

Where the Massachusetts rules provide that for a manhole below the tubes one or more stays shall be provided on each side of the manhole, attached to the rear head of the boiler and passing through the front head, secured with nuts inside and out, the Manufacturers' committee recommends that these stays shall not be required to pass through the front head because of the difficulty in keeping these joints tight; and that

other equally strong means of staying may be adopted.

In regard to the thickness of cast-iron nozzles and fittings it is recommended that the requirement be made to agree with the present manufacturers' standard as adopted by the American Society of Mechanical Engineers and the Master Steam Fitters Association.

Rivet Holes

IN regard to the matter of rivet holes, which by the Massachusetts rules are required to be drilled full size with plates, butt straps and heads bolted up in position, or punched ¼ in. less than full size for plates over 5/16 in. in thickness and ⅛ in. less than full size for plates not exceeding 5/16 in. and then drilled or reamed to full size with plates, butt straps and heads in position, the Manufacturers' committee recommends that holes in fittings and nozzles be excepted so that the fittings may be drilled apart from the boiler.

Also in connection with driving rivets, rule 45 of the Massachusetts board calls for rivets being machine driven wherever possible and allowed to cool and shrink under pressure. It is not possible to comply with the latter part of this rule in the case of rivets driven by air tools or by hand, which means must always be employed where hydraulic riveters cannot reach; also no rule should discriminate against the smaller boiler shops which do not have hydraulic riveters, so that the committee recommends the elimination of this paragraph.

Tubes and Connection Flanges

IN regard to chamfering of holes for tubes, the committee recommends that the amount of radius be not specified, simply stating that the edges of tube holes shall be chamfered; and that in regard to beading the wording shall be changed to read: a fire-tube shall have the ends of the tubes carefully beaded.

As to the making of threaded pipe connections to the boiler the Massachusetts rules state that the reenforcing flanges or nozzles for steam or safety valves or feed pipe connections may be fitted with steel, bronze, composition, cast-steel or steel plate and for the safety valve or main steam connection cast iron also may be used; the manufacturers recommend that pressed steel and wrought iron also may be permitted.

Manholes

WHERE the Massachusetts rules provide for an "elliptical" manhole opening, the manufacturers recommend the word "oval," which is obviously better. In regard to the material for manhole plates they recommend that in addition to wrought or cast steel, cast iron be permitted as this is universally used in boilers in the middle west.

Where Massachusetts rules require that for a return tubular boiler 60 in. or over in diameter a manhole shall be located in the front head below the tubes, and for less than 60 in. a manhole or hand hole, the manufacturers recommend that it be optional whether a manhole or handhole shall be used in all sizes; and also the manufacturers recommend that the requirement of a handhole in the rear head of the return tubular boiler be eliminated on account of the difficulty of keeping a handhole in good order when placed in this position. In the rules of the Massachusetts board 6 handholes are required for a locomotive boiler and another is recommended, when possible, near the throat sheet. The manufacturers recommend that this last requirement be eliminated.

In place of requiring 1-in. brass washout plugs for the vertical fire-tube boilers of steam fire engines, the manufacturers recommend the requirement of ¾-in. plugs as being sufficient in size.

Supporting

METHODS of supporting horizontal tubular boilers are definitely specified in the Massachusetts rules; for boilers over 78 in. in diameter they shall be independent of the side walls, carried by steel lugs by the outside suspended type of setting; for over 54 in. diameter and up to 78 in., the outside suspended type of setting or not less than 4 steel or cast-iron brackets on each side set in pairs; for boilers up to and including 54 in. diameter, by the outside suspended type of setting or not less than 2 steel or cast-iron brackets on each side.

The Manufacturers recommend that these paragraphs be eliminated and the manufacturers be permitted to follow their present practice in construction, which has proved to be safe.

In regard to the supporting lugs or brackets, the Massachusetts board rules specifies that these shall have proper curvature and be securely riveted to the shell with shearing stress on the rivets and not to exceed 8 per cent of the allowable shearing strength as given in the table.

The Manufacturers' committee recommends that this paragraph be struck out and in place of it specifications of the American Boiler Manufacturers' Association be submitted, which state that "The boiler should be supported on points where there is the greatest excess of strength. Excessive local stresses from weight of boiler and contents must be avoided and the distortion of parts prevented by using long lugs or brackets, and only half the stress which they may carry in the seams to be allowed on rivets. The supports must permit rebuilding the furnace without disturbing the proper suspension of the boiler. The boiler should be slightly inclined so that a little less water shows at the gage cocks than at the opposite end."

Fittings and Connections

IN regard to fittings and accessories, the Massachusetts rules provide that every steam outlet which is over 2 in. in diameter except safety valve connections shall be fitted with stop valves or valves of outside screw and yoke type; the Manufacturers' recommendation is that this shall be changed to "over 3 in. in diameter," permitting the use of the inside screw valve on 2 and 2½-in. piping. It is also recommended that paragraph 5, which refers to the use of 2 stop valves to protect a man entering the boiler from danger of steam being turned into that boiler from some other source be rewritten to make the meaning entirely clear.

In the matter of blowoff connections, where the Massachusetts rule provides for 2 valves or a valve and cock in the blowoff pipe of boilers carrying 135 lb. pressure or above, the Manufacturers recommend that this requirement be made for all boilers carrying 100 lb. or over. In regard to water column connection, which by the Massachusetts rule is specified as of brass when the allowable pressure exceeds 25 lb. per sq. in., the manufacturers recommend that an exception be made for such portion of the piping as is exposed to the gases of combustion.

An isolated section referring to the test of sections for cast-iron boilers which has been placed in the part referring to boiler fittings and accessories, is recommended to be placed earlier in the rules in connection with the limitations in regard to cast-iron boilers.

Joint Factor of Safety

IN the paragraph relating to factor of safety to be used, the Manufacturers' committee recommends that those parts which specify a lower factor of safety for lap-riveted construction be eliminated as discriminating against this form of construction, which is in satisfactory use in many boilers in the middle west. Also that paragraph which bases the factor of safety upon the length of service of butt and double strap constructions be changed so that this limitation be based on actual condition of the boilers, and a further paragraph in this section relating to hydrostatic pressure tests is recommended to be changed to conform with the standard already given.

On studying the recommendations it will be seen that the chief points in which change of the Massachusetts rules is desired by the manufacturer are in regard to the lap joint construction, which the manufacturers deem safe in view of current practice in the middle west, the basing of allowable pressure and factor of safety on actual condition of the boilers rather than on age of service, and the specification of different classes of steel according to tensile strength and chemical composition. Other changes desired are largely in the way of avoiding possibility of misunderstanding between inspector and manufacturer and of overcoming some extremely awkward requirements which the Massachusetts rules specify in regard to details of manufacture.

The requests for the most part seem fair and will probably be treated by the Massachusetts Board and others having in charge the formulation of boiler rules with the same spirit of fairness and equity that have been shown by the Manufacturers' committee. It is certainly to be hoped that the action taken at New Orleans may be the means of bringing together all interested in boiler construction to work for the adoption of uniform rules and specifications in all states, thus avoiding the present conflict and uncertainty which hampers manufacturers, owners and engineers.

PURCHASING THE BOILER

Specifications for One Horizontal Return Tubular Boiler, for 125 lb. Pressure, Extension Front, Suspension Setting

By Hubert E. Collins

AFTER a consideration of the first essentials which were taken up in the Feb. 15 issue, let us follow out the example and see what should go in the specifications and plan for a boiler of 143.7 hp. A specification and plan for a single 143.7-hp. boiler and setting are here submitted which were given out by the writer on which bids were received. One point to be attained is to place all bidders on an equitable basis and so to specify all material and method of manufacturer that all must figure nearly alike. Out of 6 bids received on these specifications, there was a difference in price of only 5 per cent between the lowest and highest figures. A full explanation of reasons which will show how manufacturers might "jockey" to get the order when specifications are loosely drawn, will follow these.

Intent of Specifications

IT is the intent and purpose of these specifications to provide for the furnishing and installation of a complete boiler plant comprising one boiler in a setting by itself, grates, fronts, safety valve, feed and blow-off valves and piping, gages, water column, smoke breeching, flues, dampers, and such details as herein specified, all complete and erected ready to generate steam.

General Requirements, Type and Dimensions

THIS boiler is to generate 143.7 hp. at an equivalent of 34½ lb. of water evaporated from and at 212 deg. F. per horsepower. The boiler rating is to be based on 10 sq. ft. of heating surface per horsepower and designed to evaporate 3 lb. of water per sq. ft. of heating surface per hour.

Note: Heating surface equals ½ surface of shell plus inside area of all tubes plus water surface of heads. Top row tubes center to be 10¼ in. above boiler center.

This boiler to be horizontal return tubular type set with over-hanging cast-iron front and all parts and pieces to be designed accordingly.

Shell to be 15 ft. 6 in. over all and 72 in. diameter measured on the outside of the smallest ring of plates. Heads to be 14 ft. apart.

Materials, Quality, Thickness and Tests

THE shells and heads of the boiler are to be constructed of best open hearth homogenous firebox steel, having a tensile strength of not less than 57,000 lb. nor more than 56 per cent of ductility as indicated by contraction of area at point of fracture under test, and by an elongation of not less than 26 per cent in a test piece 8 in. long. Test specimens must be when cold capable of being bent 180 deg. flat on themselves without fracture on the outer side of the bent portion; also, after being heated to a light cherry red and quenched in water of 70 or 80 deg. F. temperature.

Specimens of all tests shall be 1½ in. wide and thickness of plate, and 3 specimens shall be taken from each plate with edges milled or planed. One specimen shall be taken from each plate for tensile test, and one specimen shall be taken from each plate for quench test; also one for cold test. These specimens shall be taken from each plate and marked for indentification and given to the consulting engineer.

Rivet steel shall have a tensile strength of 45,000 to 55,000 lb. per square inch., the yield point to be not less than one-half the tensile strength and the elongation 28 per cent in 8 in. Rivet steel of the full size as rolled shall pass the same bending tests as specified for shell plates. Two tensile tests specimens shall be furnished from each melt of rivet rounds. In case any one of these develop flaws or breaks outside of the middle third of its gage length, it may be discarded and another test specimen substituted therefore.

Two cold bending and 2 quenched bending specimens shall be furnished from each melt of rivet rounds.

Boiler shell steel shall contain not over 0.03 per cent of phosphorous and not over 0.04 per cent of sulphur.

Shells and Heads

THE shell plates are to be 7/16 in. thick, the heads ½ in. thick. The shell is to be in 3 courses, and the middle one must be of the smallest diameter. The edges of the plates must be planed at an angle of

about 15 deg. before they are put together, and calking must be done with a round nosed tool. Heads must be flanged by the spinning process to a radius of not less than 1½ in., and they must be annealed after flanging. The flange must be free from cracks or flaws.

Riveting

THE girth seams are to be of the single riveted lap joint type, rivets to be 13/16 in. diameter, 1¾ in. pitch, lapped 2⅝ in. The horizontal seams are to be placed well above the fire line, and are to be of the butt, double strap type, with inside and outside straps. The rivets are to be 13/16 in. diameter, and pitched 3¾ in. apart from center to center on 4 inside rows, 7½ in. pitch on 2 rows next to outside and 15 in. pitch on 2 outside rows. The straps are to be ⅜ in. thick. The rivet holes are to be punched ⅛ in. smaller than rivets, the plates then being bolted together, the holes are to be drilled in place 1/16 in. larger than the diameter of the rivet. After drilling, the plates will be separated and the burrs, oil and dirt completely removed. The course will then be re-assembled and the rivets driven under hydraulic or pneumatic pressure. No rivets are to be driven in unfair holes. Should any holes be the least unfair, they are to be brought in line by the use of a reamer or drill, and in no case will a drift pin be used for this purpose. Rivets will fill the holes completely, and be of such length that they will form a full clean head without unduly over-flowing the dies.

The rivets driven under hydraulic pressure, s.w.p. including those used in shell, nozzles, manholes, hangers, and flanges, will be allowed to cool and take their shrinkage under pressure.

The bidder must check rivet sizes and pitches here given, to assure an efficiency of joint of 94.1 per cent strength of solid plate.

Bracing

THE heads are to be braced to the shell above tubes by 24 radial braces to each head, these braces to be of weldless style 1¼ in. diameter or equivalent. None of these braces are to be less than 3 ft. in length, and each to be fastened to shell and heads by 2 13/16-in. rivets. Also 2 1⅝-in. through rods below tubes and 2 1⅛-in. weldless braces in back head below tubes.

The through braces must be upset on ends and have nut and washer both outside and inside plate. Braces of iron to have tensile strength of not less than 45,000 and steel 54,000 lb. per sq. in.

Bidder must check the number of braces so they will be sufficient and properly distributed for 125 lb. s.w.p.

Tubes

THERE are to be 124 tubes 3 in. diameter and 14 ft. in length, of best lap welded steel, set in vertical and horizontal rows with a clear space between them vertically and horizontally of 1 in. except the central vertical space which shall be 2 in.

Holes for tubes shall be reamed 1/32 in. larger than the tube, and each hole to be rounded on each side to 1/16 in. radius and not beveled as in usual practice. Tubes are to be set with Dudgeon expander and beaded over on each end with improved pneumatic tools.

Manholes, Handholes and Suspension Brackets

THIS boiler is to have 2 manholes 11 by 15 in., one with extra heavy pressed steel internal frame, with suitable pressed steel plate, yoke and bolt, located in shell on top in center course with long diameter set girth-wise, the proportions of the whole to be such as will make it as strong as any other portion of the shell of like area; and one manhole flanged in front head below tubes with suitable plate yoke and bolts.

One handhole 4 by 6 in. to be located below tubes in rear head with suitable plate, yoke and bolt.

The manhole plates are to be of Eclipse pressed steel with metal gaskets capable of resisting 1500 lb. pressure per sq. in.

This boiler is to have 2 pressed steel nozzles, one, 6 in. internal diameter for steam pipe, and one, 6 in. internal diameter for safety valve connection riveted to the boiler shell on top and in the middle of the front and rear courses. Both nozzles are to be accurately squared on top flange, faced and drilled to A. S. M. E. extra heavy pipe dimensions.

This boiler is to have 4 heavy loop brackets, 2 on each side, securely riveted in place.

Feed Pipe

ONE heavy brass sleeve threaded for internal 1½-in. feed pipe is to be screwed into the front head on a line 3 in. above top row of tubes and 6 in. from shell, and to connect there to a 1½-in. galvanized iron feed pipe extending from front head 3/5 of the way back, then across boiler to above central space between tubes having on the end an elbow looking down. This internal feed pipe is to be properly hung or braced from shell or heads to prevent vibration.

Blow-Off Flame Pipe and Cock

THIS boiler is to have a pressed steel flange riveted on the bottom of shell about 8 in. from the back head and tapped for a 2 in. blow-off pipe.

A 2-in. blow-off pipe to be of extra heavy wrought iron; one piece is to extend down from boiler shell low enough to be on a line just below the cleaning out door in rear wall of setting, then turn with an extra heavy cast-iron ell and extended in one piece through the rear wall of the setting beneath the cleaning out door and have attached thereto, one 2-in. extra heavy iron body ———— gate valve and a 2-in. extra heavy nipple ending with a 2-in. extra heavy iron body ———— blow-off valve. The blow-off pipe is to be protected with a fire clay tube on the vertical run, and the horizontal run inside the setting must be set inside a trench which will clear the pipe both sides, top and bottom at least 1 in. all around. The openings are to be filled with asbestos wool.

Front and Castings for Setting

THIS boiler is to be provided with a heavy overhanging cast-iron front, and so arranged as to be fastened together in the most approved manner. The cast-iron ring of front is to have heavy double fire doors fitting against planed faces and air tight all over, and so arranged that all tubes can be easily cleaned.

The front proper will have 2 furnaces and 2 ash-pit doors with frames closely fitted and hung with suitable fastenings to prevent warping. Liner plates, (perforated) will be placed in each furnace door, and registers in both furnace and ash-pit doors. Hollow door handles are to be furnished on furance doors.

Mouth Pieces

MOULDED fire brick mouth pieces are to be furnished of ———— manufacture, or equal. Extra heavy side pieces and dead plate are to be furnished.

(To be continued)

DETAILS OF POWER PLANT DESIGN

Live Steam Piping

By Charles L. Hubbard

ONE of the very important items of power plant design is the arrangement of the piping systems for both steam and water. High-pressure piping, exhaust, and feed piping, will be taken up separately, but before these are touched upon, some matters relating to pipe and fittings in general will be given.

Piping Materials

NEARLY all of what is known as wrought-iron pipe is in reality a soft and ductile form of steel. There seems to be no especial advantage in using wrought iron if the right quality of steel can be secured, although some engineers seem to prefer it. Wrought-iron pipe is not usually carried in stock to any great extent and should be ordered well in advance if it is to be used in any considerable quantity. Wrought-iron and steel pipe are made "standard weight," "extra strong" and "double extra strong."

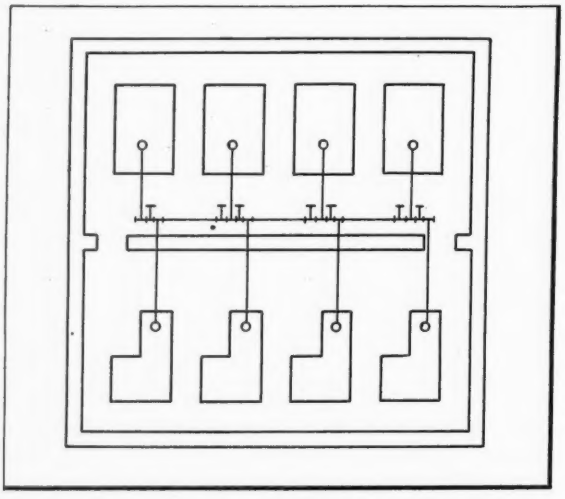


FIG. 1. BACK TO BACK POWER PLANT ARRANGEMENT

For all pressures up to 125 lb. per square inch the "standard" is amply strong, and some engineers use this weight for considerably higher pressures. Tests seem to show that pipe of this strength is sufficiently heavy for the pressures used in ordinary power work at the present time.

When particularly exposed to corrosion, it is well to use extra heavy pipe, this applies to feed lines, sealed returns, underground drip piping, and lines that are to be run in inaccessible places not easily reached for repairs. The outside diameter of all weights of pipe are made the same size, the extra metal being on the inside so that the same fittings may be used for all, if desired.

Seamless drawn brass and copper tubing may be had in sizes corresponding to standard wrought-iron pipe, and is used for the connections at the boiler fronts, feed lines between pumps, heaters, and boilers, and for coils in hot-water heating and storage tanks. It is more durable than iron pipe when in contact with hot water and is used principally on this account.

Large exhaust lines, where the pressure is low, are often constructed of spiral riveted galvanized-iron pipe. It has the advantage of lightness, and is made up with standard cast-iron fittings the same as wrought-iron pipe, and may therefore be easily joined to other parts of the piping system.

Pipe fittings of cast iron are commonly made in 3 weights. The lightest for low pressures, such as exhaust or condenser connections; standard weight, for pressures up to 125 lb. per square inch; and extra heavy for higher pressures up to 250 lb. When pipes are to be joined permanently, couplings are commonly used, but if it is desired to make any part of the work removable, unions or flanges are employed. In the best class of high-pressure work, especially for the larger sizes, the engineer usually calls for whole pipe between flanges, that is, the use of couplings is prohibited.

All steam and water connections about boilers, engines, pumps, heaters, etc., should be so made up that the piping may be easily removed for repairs. Screwed brass unions are commonly used for the smaller pipes, up to 2 in. or so, but for larger sizes, the flange union should always be used, as it is easier to keep tight under high pressures.

Pipe bends of various forms are commonly employed in making connections about boilers and engines for taking up the expansion and removing the strains from

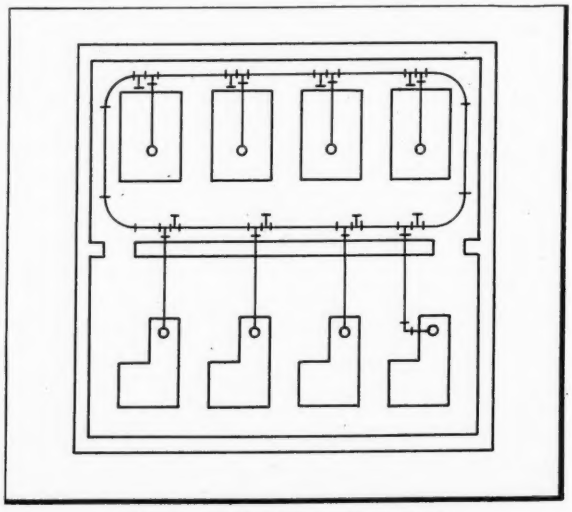


FIG. 2. RING SYSTEM OF PIPING

the joints. Connections made in this way are less rigid than when straight lengths of wrought-iron pipe and cast-iron fittings are used. Pipe bends are often employed in hot-water or steam work where it is desired to reduce the friction in the pipe to the smallest possible amount.

Bends are commonly made with a minimum radius, equal to 5 diameters of the pipe, with 4 to 6 in. of straight pipe at each end next to the flanges. In the case of low steam pressures the flanges are simply screwed onto the pipe ends, a thin gasket of sheet packing placed between them, and then the joint drawn together with bolts. For high-pressure work more care must be taken to make the joints tight and durable. The 3 forms of flanges in most common use are those with a plain face, the tongue and groove, and the raised face with inside bolt holes.

There are numerous ways of securing the flange to the pipe in order to make a tight joint. One of the

simplest and most satisfactory, considering first cost, ease of repairing, and freedom from leaks, is made by threading the pipe with a standard taper and screwing on the flange by power until the end of the pipe projects slightly, and then facing off the flange in a lathe. Another method is to round off the inner edge of the flange, and peen over the end of the pipe and face off in a lathe as before. In some of the best examples of modern power work wrought-iron pipe is used with flanges of the same material welded in place.

The principle objection to the tongue and groove joint, and also to the raised face, when there is considerable depth of step, is the difficulty experienced in springing apart a heavy line of piping to remove a section or to repack a joint. There is probably no better form of gasket for high-pressure work than one of corrugated copper, placed inside the bolt circle. This is also made in special forms for use with the grooved and raised face flanges. Low-pressure piping is commonly made up with some form of sheet packing cut to the proper form and size. The best pure sheet packing is composed of rubber and certain heat resisting substances properly mixed and vulcanized.

The method of supporting a system of heavy piping is a matter of much importance and should be given careful consideration. Pipes hung from overhead construction should be supported by some good form of adjustable hanger so that after the proper grade has been secured, each hanger may be drawn up to carry its share of the load. Main headers and other pipes of large size are best carried on rolls or chairs supported on brick or concrete piers. The best forms are arranged for adjustment by means of wedges and nuts. They also have an adjustable sidewise movement for securing the proper alignment.

In the case of isolated plants in office and similar buildings, care should be taken to prevent the pulsations of the engines from being communicated through the piping and hangers to the rooms above. This may usually be done by supporting all piping connecting with the engines from the basement floor, instead of hanging it from the ceiling construction, as is often done in cases of this kind. This may be done, as already stated, by the use of masonry piers, or pipe columns, with the lower end embedded in the concrete floor.

When, for any reason, it is necessary to use overhead hangers in certain cases they should be provided with springs and safety devices for catching the pipe should the springs fail.

Laying Out a System of Piping

THE design of a system of piping for a high-pressure steam plant should be carefully worked out in detail before any of the apparatus is installed. The boilers, engines and auxiliaries should be drawn to scale in their true positions, and then connected in a manner which best meets the requirements of local conditions.

Among the conditions to be fulfilled are pipes of sufficient size to convey the steam without too great loss in pressure; flexibility, as regards expansion and contraction; compactness, both on account of cost of construction and excessive condensation; freedom from pockets for the collection of water; and either duplication or arrangement of valves so that certain units may be cut out without disturbing others in case of repairs.

In designing electric power plants of medium size, one of 2 general arrangements is commonly followed in laying out the piping. In the "back to back" plan, so called, the boiler and engine rooms are located side by side with a brick wall between them. The engines and boilers are then placed back to back either side of the wall, which makes the piping arrangement very compact. Sometimes a single header is used as in Fig. 1, and sometimes the ring system of piping is employed as in Fig. 2. In either case, valves are so placed that any engine or boiler may be cut out regardless of the others.

In the "end to end" arrangement, shown in Fig. 3, the steam passes from the boilers to the engines by 2 paths, and any section of the main may be cut out by closing 2 of the valves. The main in this case must be made full size for its entire length and the cut out valves are necessarily of the same size, which adds considerably to the first cost. On the other hand, it practically serves the purpose of a duplicate system of piping, and in case of a leak or accident, the damaged section may be cut out by sacrificing a single engine or boiler as the case may be.

The back to back arrangement is commonly used in large plants where the engine room can be placed at a higher level than that of the boiler room. This allows

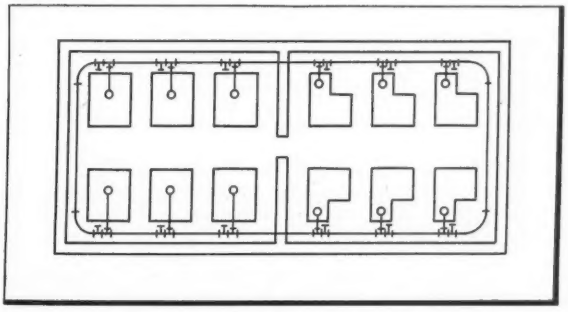


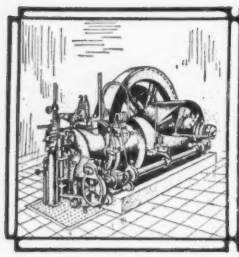
FIG. 3. END TO END ARRANGEMENT OF BOILERS AND ENGINES

the connections to be carried beneath the floor and does away with heavy exposed piping in the engine room. In this way the room can be kept cooler, and in case of leaks or breaks the escaping steam does not so easily reach the electrical apparatus. In the case of isolated plants in office buildings and institutions, it is not usually possible to carry out fully either of these arrangements, and a compromise is made of such character as is best suited to the local conditions. Connections between the boilers and main header, and between the header and engines, are commonly made with sweep bends in order to secure flexibility without the use of slip joints. If head room is limited, elbow valves may often be used to advantage in making connections with the header.

Supply pipes leading to the engines should always be taken from the top of the header in order to secure as dry steam as possible, and it is best to place a separator in each connection rather than a single one in the main leading to the engine room as is sometimes done. The vertical type of separator placed next to the throttle valve makes a good arrangement, as it insures dry steam close to the cylinder.

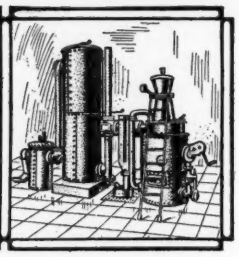
Separators not only serve the purpose of removing the suspended moisture in the steam but also act as reservoirs close to the cylinders, thus giving a higher and more uniform pressure up to the point of cut-off and also lessen the vibration in the piping due to the intermittent flow of steam to the cylinders.

H. H. KUNDE, WELL KNOWN in electrical circles in the Pittsburgh district, and who for some time past has been connected with the Doubleday-Hill Company, has severed his connection with that company, to become manager of the Pittsburgh branch of the Peerless Lamp Works, Warren, O. Mr. Kunde has established headquarters at 2014 Jenkins Arcade.



Gas Power Apparatus

Producers, Engines and Industrial Applications



A GAS ENGINE ISOLATED PLANT

ILLUSTRATIONS shown herewith give a good idea of the equipment and arrangement of the plant of the Harshaw-Fuller & Goodwin Co., of Elyria, Ohio, a manufacturing concern engaged in the production of chemicals. The fuel used is natural gas and the machinery installed consists of a 125-hp., 4-cylinder, vertical type engine, a 50-hp., 3-cylinder, and a 35-hp., 2-cylinder. Each engine drives a dynamo direct connected through a flexible connection and the engines are arranged so that any 2 units or all 3 may be paralleled on the line, if so desired. The largest unit has a 75-kilowatt Crocker Wheeler dynamo delivering current at 250 volts and running at 75 r.p.m.; the other 2 generators are 35 kilowatt, the same voltage and running at 300 r.p.m.

Regulation of the gas pressure to each engine is accomplished by means of a pressure regulator located between the main gas supply pipe and the individual supply to each engine. Starting is accomplished by means of compressed air, the 3 storage tanks being shown in the corner of the switchboard picture. 160 lb. pressure is maintained in the tanks at all times by means of the Gardner Governor Co.'s air compressor belted to the smallest engine unit. Current from this plant is used entirely for motor drive carried out on 3 lines of feeders from the top of the switchboard. The connections between generators and switchboard are made through underground conduit to the bottom of the board. The 3 left-hand panels are used for the generating unit and the one right-hand panel for distribution; the generators are all compound wound and the main switches carry the 2 outside lines and equalizer connection. The instrument equipment for the board was furnished by the Western Instrument Co. and the rheostat by the Cutler Hammer Mfg. Co. No fuses are installed, as the generator circuits are protected by circuit breakers furnished by the Roller-Smith Co.

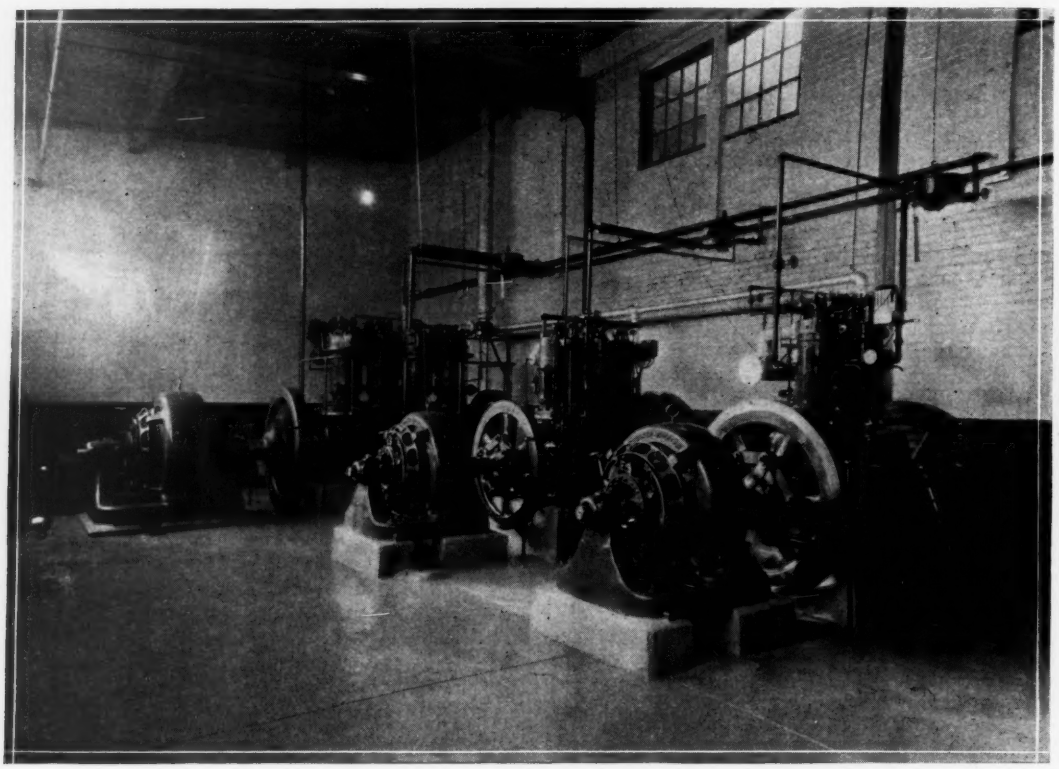


FIG. I. GENERATING UNITS OF THE HARSHAW-FULLER & GOODWIN CO.'S PLANT

GAS ENGINE DESIRABILITIES

By John Meyerott

FOR those who wish to buy or build a gas or internal combustion engine of any kind, I wish to say, in choosing an engine, or in determining on the points which it should have the suggestions which follow should be given attention if an engine is desired to give satisfaction or gain a reputation and hold it.

Avoid attachments as much as possible, such as exhaust and induction valve boxes, bolted on either side, top or bottom; have these cast directly to the cylinder, have removable valve-cages with standard taper fit, head cast directly with cylinder, yet so that the water jacket may be readily cleaned; avoid all gaskets between cylinder bore and water jacket. This will give a satisfactory cylinder.

The position of the igniter is a very important point to be considered. Place the igniter so the induction or incoming charge does not come directly over it, yet within sure reach of the compressed mixture. If placed within reach of the induction charge, the engine will be hard to start, as the mixture of air and fuel will have a tendency to cool the electrodes and hold any moisture that may be present and thus short circuit the current. If placed directly in the combustion chamber the points will get red hot and cause premature firing. If placed too far away with a small passage to the combustion chamber, the

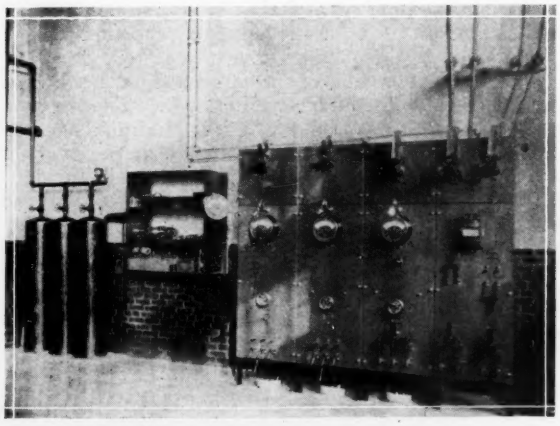


FIG. 2. SWITCHBOARD AND AIR TANKS

charge may not reach the igniter or the mixture with the products of combustion in passageway may be too weak to ignite. I would suggest that the igniter be placed so that the points will be about one inch below surface of inner wall or head of cylinder; yet the style of igniter and compression have an influence as to this point.

Pistons should be as smooth as possible on the face and concave rather than plain or convex; heavy in center, so that they will not get hot enough to cause premature firing, as sometimes happens when thin. Valves should be light as possible and made of the best material, with rather large stems to avoid breaking. Should they break, the valve being light, no damage will be done to the piston or cylinder head. If the valve is larger than necessary, it is better than if it were too small.

If the engine is to be of the open port type, the port hole should not be cored into the cylinder, but drilled and cut. If cored in, there will be a hard spot around the core, causing uneven wear on the piston and rings. The port should be long and narrow and at such a point that the piston just uncovers the opening when at the extreme out stroke.

Valves that are mechanically operated should have only one rocker arm or plunger rod for each valve only; cams as small as possible and properly designed. The governor should never be placed on or directly behind the flywheel, but back where it can be reached without endangering the body if attempting to reach it for any reason, also so constructed that adjustments may be made for any speed required while running. With hit-or-miss governing, an arrangement should be made that will disengage at any point of the stroke, with valve gear so arranged that the engine will take a charge at the first out stroke of the piston after disengagement of the governor.

If throttling type is used, the mixing valve or carburetor should be so proportioned that the proper mixture is obtained at any load and of such size that the engine will not be throttled under full load.

There are many carburetors that are entirely too small for the engines working under full load. The blame is generally placed on the engine when it is simply the mixing valve or carburetor. Have the governor connected as directly to the throttle as possible; avoid joints and levers, as these are usually small and wear surprisingly fast, resulting in lost motion and causing unsteady running.

Keep engine in pleasing proportions regarding width to length, keep flywheels close together. To do this and yet give main and crank bearings ample width, make crank disks or arms thin, but wide, hubs and rims also narrow and deep. In balancing, add to rather than core for the counter-weight. The connecting rod must have ample strength, and as long as possible, all bolts being of the best machinery steel. If bearings are bronze, be sure they are made of new stock, cooled slowly and a good running fit. If of babbitt, use only the best hard metal, for if too soft, it will soon be pounded out of shape and be worthless.

An important part of an engine is the lubrication of the cylinder, the oiler should be placed at the proper distance from either end of the cylinder. This distance depends upon the compression to a great extent. Splash oiling is not always best nor safest. The oiler should be of such construction that leaking piston rings will not affect the working of the feed valve. Cylinder oil that will stand high fire test and lubricate well, is a scarce article, and engine builders should make a demand for this to the refineries, and see that it is used in lubricating their engines.

Engines of 6 hp. and up to 30 hp. may be started by hand if a relief is provided. This should be a small cam that can be brought in contact with the exhaust valve lever, relieving the engine of about half of its compression until the engine is under way, when this cam is to be cut out. Never use the old fashioned relief valve, as it is not what is wanted. It will relieve the compression, but the most of the fired charge is also lost through it. Engines less than 6 hp. can be started easily in many ways. Large engines should have either a charge pump or compressed air; a common relief valve will be necessary, as the engine must be on a certain stroke for starting and the compression must be relieved until this point is reached, and then closed.

Avoid small moving parts, springs, gaskets and stud bolts. Make all standard taper fit and use cap screws with slotted heads if necessary. Have all parts accessible for repairs without disturbing other parts if possible, especially piping.

The sparker should have a wide range and a rotary shifting cam is the simplest and best method.

PISTON RINGS

A Quick and Correct Method of Fitting Engine Pistons

AFTER the rings have been selected, take one and try carefully to shove it straight in so that it will have a common center with the cylinder. If the ring is of the diagonal slot type, and its diameter is a little large, the ends will run upon each other, throwing the edges out of line; while if a ring with square cut overlapping ends is used it will not go in at all. Therefore, the ends must be trimmed off so that when the ring is well up into the cylinder there will be a space of from 8/1000 to 15/1000 in. between the ends, to allow for expansion caused by the heat of the motor.

The groove G on the block shown in Fig. 1A, is used in reducing the size of the diameter of diagonally slotted rings. A thin, smooth, flat file is best used for this purpose, and it should be placed between the ends of the ring, with its bottom edge in the groove G. The ring must then be pressed together so that the ends bear against the surfaces of the file as it is moved

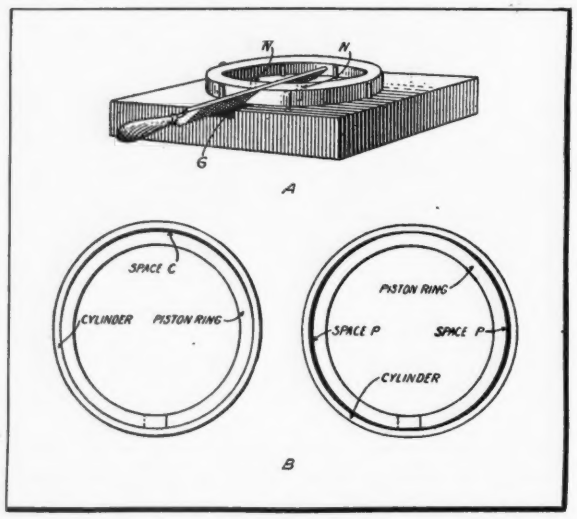


FIG. 1. A, HOLDING RINGS TO FIT ENDS; B, IMPROPERLY FITTING RINGS

forward. The ring should be frequently tried in the cylinder in order that the space is not filed to exceed the above dimensions. The inside portions of the rings near the end should rest against the nails N, in order that they may not be broken off when filing the slot.

Having attained the proper space between the ends of the ring, place a light in the cylinder behind it, and see how its face conforms to the wall of the cylinder. If there is good contact all around, the ring is ready to be fitted to the piston; but if the contact is poor, either the ring or the cylinder is out of round, leaving space between cylinder wall and the ring, as at C and P in Fig. 1B. If the fault lies in the ring, the face can probably be dressed down to fit, or another selected; but if the cylinder is badly out of round it will have to be rebored or reground, or both, as the case may be, or replaced with a new cylinder.

When the rings have been adapted to the cylinder, the next operation is to fit them in their respective grooves on the piston. Begin with the ring selected for the bottom groove, so that the ring will be the first to be slipped on to the piston. First try the ring without slipping it over the piston by inserting it in the groove and rolling it around its circumference, as indicated in Fig. 2B. It should fit snugly, as at A, Fig. 2A, but still be free to slide in and out easily; if it binds in any place, apply a thin film of red or black lead or prussian blue in the same manner as used scraping bearings, to locate the high places, then dress down with the thick, smooth, flat file and try again. When filing is necessary, it should be confined to one edge in order that at least one good edge is re-

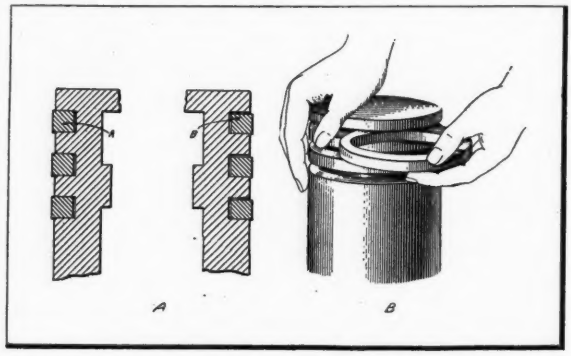


FIG. 2. A, SECTIONAL VIEW OF PISTON; B, TRYING THE RING IN THE GROOVE

tained, for it is almost impossible to secure as regular a surface with a file as that made by a grinding machine. An example of ill-fitting rings is shown at B, Fig. 2A and in Fig 1B the space C shows that the ring was sprung in putting it on the piston.

A very simple and effective means of holding a ring for fitting is shown in Fig. 1A. The ring is placed on a block of wood, and a few small nails driven into the block, both inside and outside of the ring, in such a manner that the ring is held securely in place for filing. The heads of the nails are then cut off, the ring removed, and the nails filed down so that they will extend just below the top surface of the ring when it is replaced on the block. With the nails well placed,

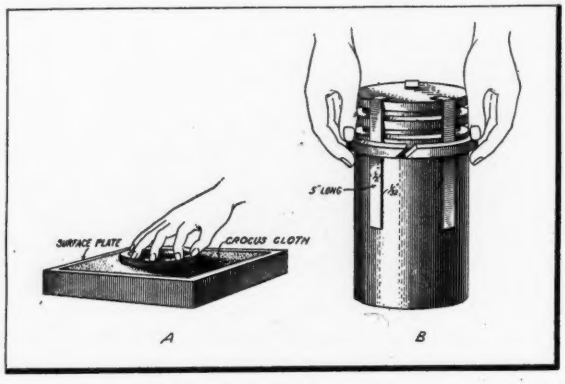


FIG. 3. A, DRESSING OFF THE SIDES OF A RING; B, REMOVING OR REPLACING A RING

there will be no danger whatever of breaking the ring when filing.

Another simple and effective method of dressing down a ring to fit a groove is shown in Fig. 3A. A piece of crocus cloth is laid upon a surface plate or some such flat surface, then the ring is carefully rubbed around on it in the manner indicated in the illustration. Emery cloth should not be used in this work, as cast iron is very porous. Grains of emery

which will remain in the pores, work out later, and cause damage.

Having fitted one ring, put it in place immediately, and repeat the operations with the next ring. A quick and safe method of slipping rings into their grooves is shown in Fig. 3B. Take three strips of sheet metal, brass, or tin, for instance about 1/32 in. thick, ½ in. wide, and 5 in. long; bend these at right angles, and hang them on the edge of the piston at equal distances apart. The ring may then be slipped over these till it is opposite its groove, when the strips may be removed and the ring allowed to slide into place. The same strips may also be successfully used in removing rings.—Gas Power.

SARGENT GAS ENGINE DRIVEN AIR COMPRESSOR

Unit for Small Plants Compresses Air in Two Stages

WITH the increasing demand for compressed air for industrial purposes and its economical compression in large or small quantities, there have been many improvements and refinements in compressors which have increased their efficiency and reliability, yet the thermal and volumetric efficiency of many air compressors is still too low.

On account of the high cost of electric power and the floor space and low mechanical efficiency of compressors belted from gas engines, small quantities of

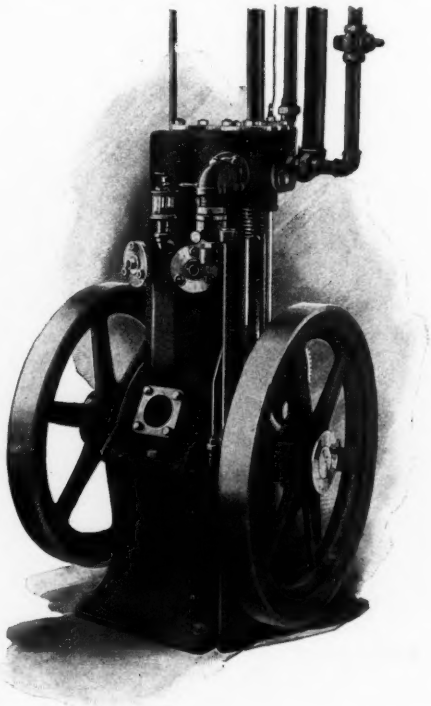


FIG. 1. SARGENT GAS DRIVEN AIR COMPRESSOR

compressed air are not available to many who would use it if the cost of compression were less.

To meet the demands for a self-contained, highly efficient, gas driven air compressor the machine shown in Figs. 1 and 2 was brought out. It consists of a vertical gas engine with a differential trunk piston, the annular space around it being used for compressing the air. As there is but one piston, one connecting rod and one crank shaft for both the gas engine and the compressor, the combined efficiency of the unit is naturally high.

On the up stroke air is drawn into the crank case through the port K, Fig. 2, when it registers with the corresponding port on the crank disk J. On the down stroke air is compressed in the crank case and flows through the valve E into the annular chamber made by the differential piston. On the return stroke this air is forced through the discharge valve H and outlet I to the storage tank or receiver, during which time

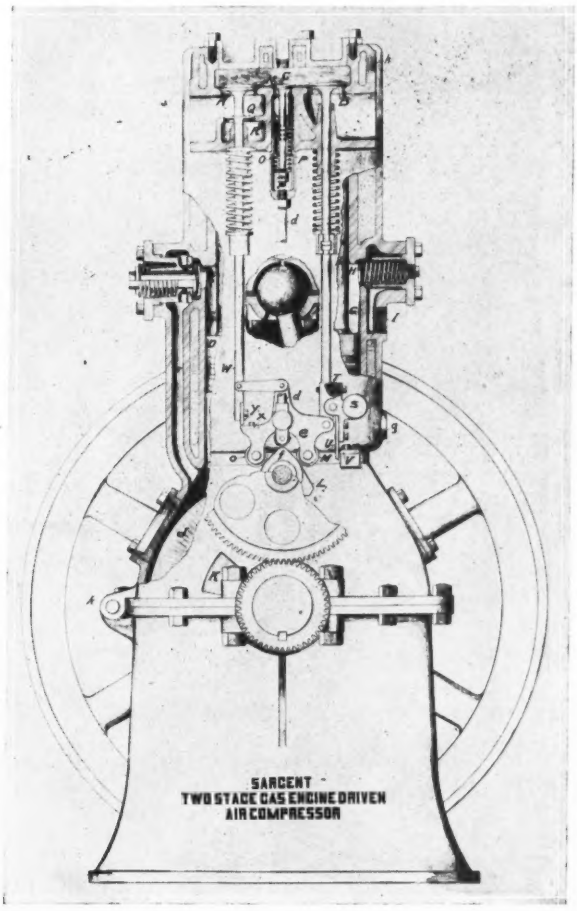


FIG. 2. SECTIONAL VIEW OF SARGENT AIR COMPRESSOR

the crank case is again filled. On account of the large surface surrounded by cold water and the short distance the heat has to travel when generated in the annular space by compression, the thermal efficiency should be higher than in compressors having a small cooling surface per unit of volume.

As the pressure is always down, a clearance of 1/100 of an inch can be maintained easily, as manifested on the diagram, Fig. 3, taken with a 100 lb. spring, and discharge pressures from 60 to 140 lb., in a high volumetric efficiency. Careful inspection of the compression curve shows that it approaches very closely the isothermal line, an indication of the unusual cooling of the air during compression. The diagram, Fig. 4, taken from the crank case with a 20-lb. spring shows an absolute pressure of 21 lb., when compression begins in the second stage. The cold water surround-

ing the annular chamber in which the air is compressed and cooled passes up and around the combustion cylinder sufficiently warm to maintain a high efficiency therein. Figure 5, is a diagram from the gas engine explosion chamber.

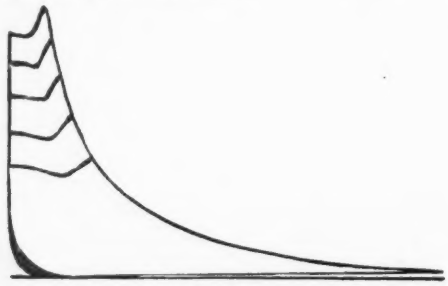


FIG. 3. AIR CYLINDER PRESSURE DIAGRAM TAKEN WITH 100 POUND SPRING

The engine proper is of the 4-cycle type and as air is compressed every stroke the 2 flywheels and crank disks are made heavy to maintain a sufficiently uniform speed.

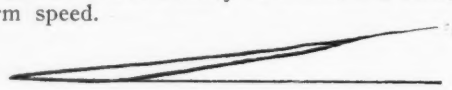


FIG. 4. PRESSURE DIAGRAM OF CRANK CASE

An inertia governor S, falling slower than the spring seated exhaust valve B when engine tends to run above normal speed, allows U to engage V, hold-

FIG. 5. DIAGRAM FROM GAS ENGINE CYLINDER

ing the exhaust valve open and the inlet valve stem W in such a position that X will miss Y and the inlet valve will remain closed. When the speed drops U will miss V and the engine will resume its normal operation.

Either gas, gasoline or kerosene are used for fuel. When gas is used it is admitted through a graduated valve to the space R from which it flows to the explosion chamber C with the air when the collar Q on the admission valve stem rises. Gasoline or kerosene are taken in through a mixing valve on the air pipe, Fig. 1.

Compressed air which the engine compresses is used from a storage tank for starting through the valve N, positively opened at the beginning of each working stroke as long as compressed air is turned on and the pressure is greater than in the explosion chamber. The crank pin is accessible through the hand hole plates, or the piston rod and crank may be adjusted or removed by turning back the cylinder on the hinge k, Fig. 2.

Compressors of this type will compress air to 200 lb. gage or to any lower pressure at which unloader is set. Compressors are made in 4 sizes to compress from 9 to 150 cu. ft. of free air per minute.

These compressors were designed by C. E. Sargent, Chicago, Illinois.

FIRST ANNUAL NATIONAL GAS ENGINE SHOW

THE first annual national gas engine show, to include everything in gas power and allied lines, will be held in Milwaukee, June 17 to 22, inclusive, in connection with the convention of the National Gas Engine Association. This is in accordance with plans laid at the last meeting of the Association in Cleveland. The place of the show will be the Auditorium, where about 100 exhibition spaces have been laid out.

The central portion of the main floor will be devoted entirely to engines of various kinds, and these will be shown in actual operation on gas or gasoline. All engines will be suitably muffled and shown under actual running conditions, a feature that will make the show absolutely unique in exhibits of gas engines. Not only will there be shown the stationary or heavy-duty type of engine, but there will also be the small farm engine, the marine and automobile and possibly aeronautic motor. Space adjoining the building will provide an area for tractor exhibits.

Surrounding the engine spaces will be spaces allotted to the manufacturers of accessories, showing batteries, spark plugs, coils, magnetos, lubricators and all allied or accessory lines.

The exhibition will be opened at 1 p. m., Monday, June 17, and will be open from 8 a. m. to 10:30 p. m. daily up to Friday night, June 21.

At the show in Milwaukee there will be special provision for the running of engines, as above explained Both dealer and prospective individual buyer can see there the various types of engines actually running, and can compare one type with another at close hand.

The show will be held in a section of the country within which in a radius of a few hundred miles there are built by far the largest percentage of gas and gasoline engines annually produced in the world. In this same section there are manufactured some of the largest units the world has furnished, as well as some of the smallest.

Applications for space, etc., should be made to O. C. Parker, president of the Association.

The program for the semi-annual meeting of the National Gas Engine Association is being arranged for, and will provide features having specially in mind the show. There will be sessions at which papers particularly for the dealers and the individual users will be prepared by men of high standing in the business. Special sessions for the discussion of subjects of construction of engines will be held, having in mind the manufacturers in attendance.

The recently appointed "eastern" and "western" membership committees for the Association have been actively at work, and quite a number of new members have been received. As the annual dues are but $5 and initiation $5, the cost is nominal and any persons who are interested in the promotion and welfare of the gas and gasoline engine and allied lines are eligible to membership. Applications for membership may be sent to any of the officers, or to the chairman of the respective committees, as follows: O. C. Parker, president, Lacrosse, Wis.; H. W. Jones, vice president, Chicago; Otto M. Knoblock, treasurer, South Bend, Ind.; Albert Stritmatter, secretary, Cincinnati, O.; Mark W. Heath, chairman western membership committee, 1429 Michigan avenue, Chicago; M. A. Loeb, chairman eastern membership committee, Cincinnati.

CONVEYING AND ELEVATING MACHINERY

Use of the Bucket Elevator in the Power Plant, Types, Capacities, Costs, Economical Application

By Reginald Trautschold

IN the typical power houses described in a previous installment both the supply coal and the refuse of ash were carried from a lower level to a higher one by a system of inclined belt conveyors. Systems of flight conveyors might have been used for such operations but with a sacrifice of economy and, to a lesser extent, screw conveyors may be used to elevate as well as to convey. Such practice of elevating by systems primarily adapted to conveying purposes necessitates considerable space for apparatus and though this is frequently available when the material handled has to be carried a comparatively long distance as well as elevated—two distinct operations which may thus be performed at the same time with economy—there are many installations in which space is limited and a system for elevating must be employed that permits the load to be carried vertically, or at a steep angle.

When it is advisable to have material elevated more or less continuously and when such operation may be economically performed over an appreciable length of time—such as the handling of coal and ash in the power house—a system of buckets attached to an endless chain or belt is the logical and economical solution. Such a system, known as a bucket elevator, may be operated in a vertical, or nearly vertical plane, the rising buckets carrying the load and passing over a head sprocket or pulley where the load is discharged and being returned empty on the downward path after which the buckets pass around a tail sprocket or pulley and are ready for another load.

Types of Bucket Elevators

THREE distinct types of such elevators exist; 1st, those in which the buckets are attached to a single strand of chain, such type necessitating a slight obliquity to the elevator that the buckets may discharge their load without undue spill and free from the elevating mechanism; 2nd, a similar type in which 2 strands of chain are used, attached to the 2 ends of the buckets, permitting such elevators to rise vertically as the returning buckets may be deflected on the return path by knuckle or choke sprockets so that their lead from the head sprockets will be in the oblique plane necessary for proper discharge of load; and 3rd, the belt type of elevator in which the buckets are attached to an endless belt in place of chains, such type must also be run in a plane that makes a slight angle with the vertical, in order properly to discharge.

Various modifications of these 3 simple types have, of course, been developed, such as elevators of the continuous bucket type in which the buckets are simply attached to one another in continuous succession, thus doing away with the necessity of chains or belts for carrying the buckets; and various types in which the buckets are carried in a more or less horizontal plane after being elevated, thus obtaining perfect discharge or discharge at some point some distance from the plane of elevation, or before being elevated for various reasons pertaining to loading. But as the 3 simple systems can accommodate any ordinary installation as economically, and frequently more so, than the more complicated systems that are often installed for elevating purposes, they alone will be considered in this discussion.

When bucket elevators are used in the power house they are almost invariably employed in connection with some conveying machinery of the kinds already discussed. That is, they may be used to elevate coal from the plane on which it is received, or to which it may have been delivered by other systems of conveying machinery, to the plane for distributing the coal to storage; or they may be used to elevate ash from the point at which they are taken from the power house to some overhead storage. Portable systems of such apparatus for loading ash carts and movable systems for loading overhead storage bunkers that are not situated so as to permit their being economically filled by conveying apparatus, find important fields about the power house. In fact, any operation of elevating that requires mechanical assistance for efficiency usually calls for a bucket elevator

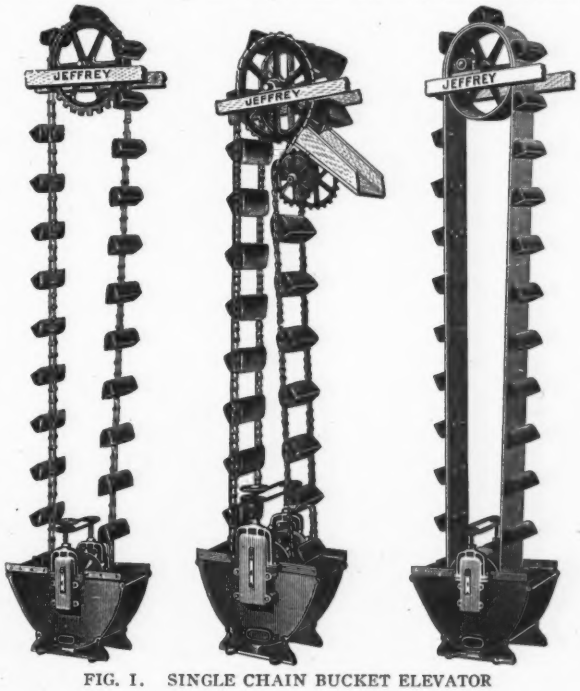


FIG. 1. SINGLE CHAIN BUCKET ELEVATOR
FIG. 2. DOUBLE CHAIN BUCKET ELEVATOR
FIG. 3. BUCKET ELEVATOR OF BELT TYPE

of some description. The following discussion will therefore be of interest to the power house management in that the economic value of the system and its cost of operation will be brought out as comprehensively as a short article will allow.

Capacity of Bucket Elevators

NECESSARY size of the elevator for its work is naturally the first consideration. This depends upon 3 points; 1st, the size of the buckets; 2nd, the number of buckets per given section of conveyor, i.e., their spacing; and 3rd, upon the speed at which the elevator is run. In a power house the first of these conditions is limited to a comparatively narrow economical range, for the coal to be elevated is almost invariably of the smaller sizes, or, if ashes, they contain no large clinkers, for in plants where run-of-mine coal is used it is crushed before delivery to the elevator. The shape of the buckets has also been standard-

ized and buckets of various makes have about the same capacity for any given length and width of bucket, the 2 dimensions which designate their size.

The second condition has been pretty will standardized by practice and should be such as to allow the buckets, as they revolve about the tail sprocket, to pick up a full load at an economical rate of speed. The spacing of the buckets is, therefore, governed considerably by the speed of the elevator as the size of the coal or ash clinkers may be disregarded.

The third condition, that of speed, has also been standardized in good practice and usually is limited to speeds between 100 and 200 ft. per minute.

Ashes are usually handled at an elevator speed of about 150 ft. per minute and coal at a somewhat higher speed, for fine coal the most economical speed being about 175 to 200 ft. per minute. These speeds apply to elevators with buckets spaced according to common practice. The capacity of elevators with other spacings of buckets will vary inversely with the distance between the buckets provided the speed of the elevator is kept constant. The speed effects the capacity directly if the position of the buckets is kept the same. Hence, to obtain the maximum efficiency from a bucket elevator the speed should be decreased for elevators with buckets closer together than will be indicated and increased for elevators with buckets further apart.

Loading of the buckets is a further important consideration in the question of capacity and also in the economy in the use of power required for the operation of the system. The load should be supplied to the buckets sufficiently rapidly and in great enough quantity to fill economically each bucket, but to supply the load so rapidly as to flood the buckets and cause them to be dragged through an unnecessary amount of material in the elevator boot, or receptacle from which the buckets pick up their load, will not only cause a periodic necessity for stopping the supply of material but will also greatly increase the power necessary to operate the elevator at its rated capacity. Table A in the Practical Reference Tables gives the capacity of various sizes of bucket elevators, size of bucket, when economically loaded and handling coal or ash. The speeds given and the spacings indicated are those that have proved satisfactory in general practice but considerable variation is permissible without sacrificing the economic operation of the elevator, particularly in the question of spacing of buckets for sizes of elevators near those for which change of spacing is suggested.

Power

CONSUMPTION of power by a bucket elevator, under known conditions of load elevated per unit of time, and height through which it is elevated, is easily ascertained, for the simplicity of the apparatus resolves the problem into one of ascertaining the foot-pounds of work done by multiplying the load by the distance through which it is elevated. The loss of power due to inefficiencies of the driving mechanism and the work required to drag the buckets through the material to be elevated and thus load them consumes about one-third of the power that is required by the elevator for its proper operation under load. That is, in common practice, the horsepower required to operate a bucket elevator that is efficiently loaded is equal to the product of the load handled in tons per hour and the height of the elevator in feet divided by 1000 to which must be added 50 per cent. This relation expressed in the form of a convenient equation is given as follows:

$$\text{Hp.} = \frac{WH}{666}$$

Where:

Hp. = Horsepower required.

W = Weight of load elevated in tons per hour.

H = Height to which load is elevated, height of elevator.

Initial Cost

THE 3 simple types of bucket elevators naturally vary considerably between themselves in initial cost, and they not only vary on account of the greater number of parts to a double chain elevator than to a single chain elevator, or one in which the chain is replaced by a belt, but each type may be more or less expensive as a whole. For instance, any of the 3 types may be equipped with steel elevator buckets or malleable iron ones. The malleable iron buckets are considerably more expensive than steel buckets, of the same size, and affect the total cost of the equipment to an appreciable extent.

Malleable iron buckets, however, are ordinarily much more durable than the cheaper ones, perticularly for use on elevators which are to carry ash, as the corrosive action of damp ash on steel is more destructive than on malleable iron, and furthermore, the effect of hot ash on the malleable iron buckets is much less injurious than upon steel. Thus the greater initial cost of the malleable iron buckets is seen to be offset by their greater wearing qualities.

Cost of buckets of either class naturally depends upon their size and a very constant relation exists between the cost of the buckets and their size—size of elevator—or capacity when their usual spacing in elevators is taken into consideration. That is, the cost of the buckets required for an elevator of any given size or capacity is usually a fixed percentage of the cost of the entire equipment.

The question of chains for elevators is also one that directly effects the cost of the equipment, but in this case the chains have been so standardized that only 1 or 2 kinds are in general use and, though these vary considerably between themselves, a close approximation of their average cost varies directly with their working strength, and hence also vary with the load carried or size of elevator. The various standard elevator chains that are obtainable also permit the use of lighter and cheaper chains in elevators of the 2-chain type and therefore the cost of a single or double chain elevator, that is economically proportioned, will show little difference in cost other than the extra expense entailed for the double sets of sprockets, etc.

Cost of the elevator boot, or receptacle from which the buckets pick up their load, the shafting, etc., and driving machinery varies so little between the 3 types of elevators, except for the extra sprockets, etc, required for the double chain elevator, that they may be considered constant for any given size of elevator in arriving at an approximation of the initial cost of the necessary outfit. The boot, driving mechanism, shafting, sprockets or pulleys, etc., are all parts that are required for any elevator, irrespective of its length, and the total cost of this group of parts varies closely with the size of the elevator, size of buckets.

Chain attachments for holding the buckets and the buckets themselves constitute another group which is nearly constant in cost per foot for any given size of elevator, this group consisting of 2 classes of equip-

ment, one in which the buckets are of malleable iron and the other in which they are of steel. This second group varies approximately in cost with the working strength of the chain or the load the elevator is proportioned to carry and hence also varies with the size of the buckets, this relation also holding good for elevators of the belt type.

These relations enable a table of approximate initial costs of complete equipment for bucket elevators to be derived, such table consisting of 3 groups, one for each simple type of elevator, each of which is again subdivided into a class of elevators with steel buckets and a class of elevators with malleable iron buckets and in which the total cost of all equipment depends either upon both the size of the buckets and height of elevator or simply upon the size of the buckets. See Table B in the Practical Reference Tables. This table will enable the total cost of any elevator adapted to power house operations to be easily ascertained neglecting the cost of the power unit, the discharge chute and the elevator casing. The second of these items depends primarily upon local conditions and requirments and should therefore be figured upon separately. The elevator casing may or may not be necessary, and as the elevator may be framed against a wall or as the casing may be of cheap construction or again of more expensive construction it must also be figured upon separately when required.

Operating Cost

NET operating cost of a bucket elevator system, as that of any other system, consists of 3 distinct charges; the cost of operation, the cost of maintenance and the burden of interest on investment, taxes and insurance. The cost of operation includes the expense of power, labor or attendance and the expense of supplies necessary to keep the system in good working order. The power required depends upon the tonnage handled per unit of time, and its cost upon the efficiency of the plant, cost of fuel, etc. The expense for labor or attendance for the elevator should, in an efficient plant be so proportioned that a fairly constant charge may be made against each ton of material handled to cover such expense. The supplies necessary for the outfit vary closely in cost with the amount of power consumed and may therefore be divided so that a fair charge can be made against each ton of material handled. In fact, the average cost of operation consists of 2 general charges, one depending upon the cost of power and the other upon the amount of work done or tonnage handled. Both the cost of maintenance and burden depend upon the initial cost of the outfit but this in turn depends upon the size of the buckets and may therefore be expressed in terms of tons handled per hour by the elevator or a certain charge made against each ton elevated.

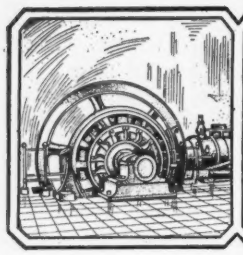
Cost of maintenance includes deterioration and this is not constant, for an elevator with malleable iron buckets costs more than one with steel buckets and the 3 types of elevators also vary in cost for elevators of the same capacity. The expense due to deterioration and repairs of the more expensive buckets is, however, about the same as that for steel buckets in total amount, though less in percentage. This is also true of the more expensive double chain elevator. That is, the cheaper elevators require more repairs and renewals than the more expensive equipment of the double chain elevator, and the sum total of all expenses of maintenance of the various types of elevators is fairly constant for any specific size of elevator and varies closely with the capacity of the elevator, being perhaps slightly more for the cheaper ones than for the more expensive elevators.

The burden, on the other hand, is less for the inexpensive types of elevators and more for those more costly. The increase in maintenance expenses and the corresponding decrease in burden and vice-versa tend to balance each other, and a fairly accurate and constant value for the net operating cost of any bucket elevator system may be expressed as a charge depending upon the cost of power and another charge depending upon the capacity of the elevator or tonnage handled per hour. Hence, this important point may be resolved into a net operating cost per ton elevated. Expressed in a convenient form for reference the net operating cost of the average bucket elevator is given in Table C in terms of total cost of power required per hour and capacity of elevator per hour and also in net cost per ton with power valued at $60.00 per horsepower year or 2c per hour; such values depending, of course, on the condition that the elevator is in frequent use and that ordinary good care is given to all equipment.

The bucket elevator is not, however, the only apparatus by which the operation of raising a load from one level to a higher one can be economically done, but it is the system that requires least space for installation and is usually the logical method to employ. The more efficient of the conveying systems that have already been discussed can perform such work efficiently when the layout of the plant permits their use. In fact, the belt conveyor can sometimes be used even more economically than the bucket elevator, space permitting, and it will be of interest to consider an installation of such character.

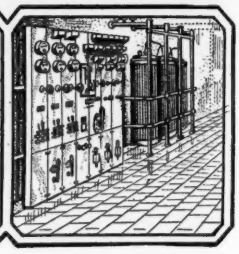
An excellent and unusual example of the use of belt conveyors for elevating purposes exists in one of the power houses previously described. In this installation a system of criss-cross belt conveyors was installed to elevate the coal to the overhead distributing conveyors, a net elevation of about 100 ft. The available space in the power house necessitated the use of 4 inclined belt conveyors, each about 100 ft. long, and the necessity of having each conveyor discharge to the next one from above made the gross height through which the load is really elevated by the system about 120 ft. The total horsepower per ton elevated by this system is about 0.2088, while if it had been possible to install a bucket elevator in place of the system employed the horsepower required per ton elevated would have been only about 0.15, i.e., the elevator would have required but about 70 per cent as much power as is necessary for the system installed. Still from an economic standpoint the wisdom of adopting the apparatus installed is conclusively shown when the net operating cost per ton is considered. The net operating cost of the belt conveyor system, based on cost of power at 2c per horsepower hour, amounts to $0.018304 per ton elevated, while if bucket elevators had been used this cost would have amounted to $0.025925 per ton. A saving of about ¾c per ton handled was therefore gained by the installation of belt conveyors.

THE ROBB ENGINEERING CO., Ltd., South Framingham, Mass., were given an order by the Boston Molasses Company to replace in the shortest possible time, its smoke stack and 2 delivery tanks, destroyed by fire. Two days after the order was received the smoke stack, which was 3 ft. in diameter and weighed 4 tons, was delivered in Boston, and was erected so that the boilers could be operated less than 4 days after the fire.



Electrical Machinery

For Generating, Transmitting and Using Current



INDUCTION MOTOR TROUBLES

Explanations of the More Common Troubles; Suggestions for Remedying Them

By Carl D. Knight

INDUCTION motors are by nature of their construction more hardy than direct-current motors and less subject to defects. There are, however, a number of troubles characteristic of this type of machines that are liable to occur which are not only annoying but often times puzzling. These troubles are enumerated in this article and suggestions are given for remedying them.

Reversing direction of rotation.—If a 2-phase motor rotates in the wrong direction it can be reversed by interchanging the external connections of either phase as shown in Fig. 1. To reverse the direction of rotation

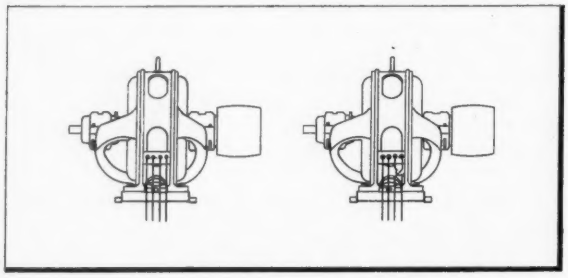


FIG. 1. CONNECTIONS FOR CLOCKWISE AND COUNTER-CLOCKWISE ROTATION OF A 2-PHASE MOTOR

of a 3-phase motor it is only necessary to interchange any two of the three external connections as shown in Fig. 2.

Heavy Starting Current

WITH squirrel cage motors this may be due to wrong connections being used in the compensator, thereby applying too high a voltage when starting. It may be remedied by changing taps in the compensator or auto-starter, so as to apply a lower voltage. Cases have been found in which the compensator was connected in such a manner as to apply line voltage to the motor when the handle was in the starting position, and a voltage much less than line voltage when the handle was in the running position. This defect is illustrated in Fig. 4. The switch moves over the contacts 1, 2, 3 and 4 in the direction of the arrows. It will be readily seen that in such a case full voltage is impressed on the motor at the first notch and is gradually lowered through the rest of the steps. This trouble would also cause the motor speed to fall off rapidly when load is applied, and cause the starting device to heat. The correct connections for a 3-phase motor are shown in Fig. 3.

Excessive starting current with either the external or internal resistance type of motor usually indicates wrong connection of the starting resistance.

Failure to Start

A BREAK in the connections between the service switch and the motor will result in the absence of voltage at the motor terminals. All connections and joints should be carefully inspected. A voltmeter or incandescent lamps connected in series may be used to test for voltage at the motor terminals. A poor joint may be of such high resistance that only a small current can pass through it, even though a voltage is shown at the motor terminals.

For resistance wound armatures look for open circuits in the resistances or poor contacts in the resistance changing device. If such a motor will not start on the first position of the starting handle, but will start on a later position it indicates that the starting resistance is too high. If the acceleration is jerky, the starting resistance is not properly graded to start the load.

An open circuit in one phase of a 2-phase, or a star connected 3-phase stator winding, will leave the motor with no starting torque, but if given a little mechanical assistance like turning it by hand, it will tend to come slowly up to speed if there is no load to start. A 3-phase delta-connected motor having a lead broken behind the terminal board will behave in the same way. If there is an open circuit in one phase of a delta-connected stator winding the motor will start and run, but with reduced torque.

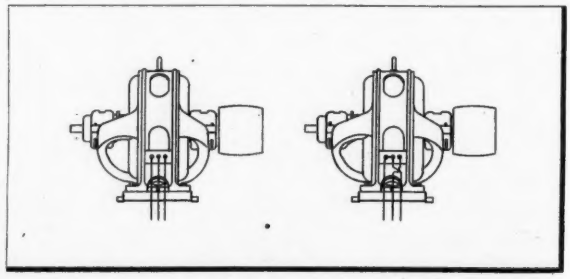


FIG. 2. CONNECTION FOR CLOCKWISE AND COUNTER-CLOCKWISE ROTATION OF A 3-PHASE MOTOR

In order to detect which is the open circuited coil, it is necessary to test with a voltmeter from one terminal of the open circuited phase to each coil in turn. Connection may be made with a coil by attaching a needle or sharp awl to the voltmeter wire and forcing it through the insulation. Repairing a coil is usually a job for an armature winder and should not be attempted by one not familiar with such work.

Two grounds in the stator windings may prevent the motor from starting because the effect is to short circuit a portion of the stator windings. A ground may be

located by connecting a voltmeter or lamps between the motor terminals and the frame. The exact location of the grounds can often be located by inspection, since the passage of current will char the insulation and core teeth. A single ground cannot be located by inspection unless there be other grounds outside the motor.

Failure to start may be due to excessive load. This usually means that the wrong motor has been selected to do the work and in that case the only remedy is to reduce the load in some way or procure a new machine.

Heating and Line Trouble

THE starting current in an induction motor is always much larger than normal running current, and if it is necessary to make frequent starts trouble may arise from overheating of the motor. In some cases it may even be found necessary to install a motor considerably larger than is needed to drive the load after it has once been started.

Low voltage, caused by improper starting connections, poor contacts, or low alternator voltage, will cause the motor to take more current than it should and so heat up. If it seems that the alternator voltage is too low, it may be possible that the wires from the alternator to the motor are too small. If the load on the motor is steady, measure the voltage at the alternator terminals and again at the service switch for the motor. Any considerable difference will indicate trouble in the line.

It sometimes happens that motors operating under a comparatively low load will blow fuses in one phase and not in the others. This oftentimes overloads the remaining phase so that it will heat up, but not necessarily blow the fuses. A motor having a starting compensator will start if the fuses are blown in one phase, because the fuses are cut out at start.

A short circuited coil in either armature or stator will cause heating in the vicinity of the defective part. There should be no difficulty in locating the coil as it will appear scorched. It is sometimes possible to locate it by passing the hand over the windings and noting the hottest place. Due to the fact that the heat will often spread to coils in the same slots which are not defective, this should not be regarded as an absolute test.

Mechanical Faults

MECHANICAL faults causing the armature to bind on the stator may cause overloading of the motor. This binding may be caused by the bearing linings becoming worn, in some instances by obstacles collecting on the armature surface. The air gap clearance should be checked at frequent intervals with a gage similar to that described in a previous article.* The clearance should be tested both at top and bottom of the armature and at each end. New bearing linings may be necessary to remedy this trouble.

In case of an external resistance motor, overloading is sometimes caused by attempting to run the machine at full load output at low speed. Motors are usually rated at top speed and the horsepower output decreases in exact proportion to the speed. The only remedy is to decrease the load.

The ventilating ducts in both armature and stator should be kept free from dust and dirt, for if they become clogged, overheating will result. Cases have been known where dirt, lint, etc., on the inside of the armature caught fire while the machine was running. A vacuum cleaner is the best thing to use to remove dirt from a machine but compressed air or a hand bellows does very well.

*The installation, Operation and Care of Induction Motors, Practical Engineer, Feb. 15, 1912.

Motors having resistance wound armatures of either type sometimes give trouble by the armature becoming heated due to an open circuit in the armature winding. If on starting, the motor refuses to run above half speed it may be taken as a certain indication of an open circuit in one armature phase. The open circuit may be in the winding itself, but is quite as likely to be in the starting resistances or in the controlling switches. If it be a motor having an external resistance armature, measure the voltage between the slip rings. If there be no voltage between any two, the fault is in the armature, but if there is voltage between all pairs of rings then the trouble is outside the armature in the controlling gear, and may be located by ringing out the different parts of the circuits with a bell.

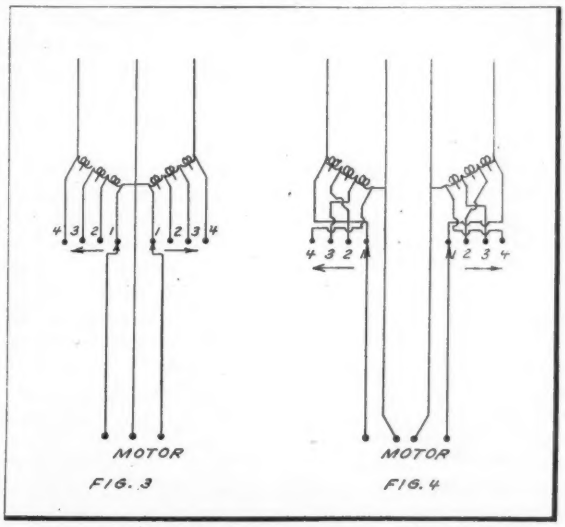


FIG. 3. CORRECT CONNECTIONS OF A 3-PHASE COMPENSATOR OR AUTO-STARTER.

FIG. 4. REVERSED CONNECTIONS OF A 2-PHASE COMPENSATOR OR AUTO-STARTER

Miscellaneous Troubles

OPEN circuits in a squirrel cage armature are rather infrequent, but if they occur will be located by excessive drop in speed and failure to carry full load. If the defect be only a poor connection in the armature local heating will be produced at the defective part.

Machines having internal resistance rotors should have the contacts inside the armature kept free from deposits of dirt and it is a good plan to lubricate these contact surfaces occasionally with a little vaseline.

Most machines are set up so as to have a little end play in the armature. It is especially desirable that machines having slip rings have this end play, as it prevents the brushes from wearing grooves in the rings. Slip rings should be cleaned at regular intervals with sand paper; never use emery. The particles of emery will imbed themselves in the rings and cause excessive wear on the brushes. If it is desired to lubricate the brushes, a very little oil or vaseline may be used, but never use enough to cause it to gum up, and in any case wipe the rings clean before applying more. In putting on new brushes fit them carefully to the rings in order that they may have their full contact surface.

In operating and caring for any electrical machinery it should be remembered that neglect and abuse will damage the machine very quickly. With good care a motor will do its rated amount of work and often more, for many years without excessive repair bills.

STORAGE BATTERY PRACTICE *

Purpose of a Battery Installation in Isolated Plants, Voltage Regulation, Boosters of Various Types, Auxiliary Apparatus

ELEMENTARY connections of a different type of externally-controlled booster from those previously described, are shown in Fig. 9. The booster field winding is connected at one end to the middle point of the battery. The other end is connected to the upper contact points of 2 carbon pile resistances. The lower end of the left hand carbon resistance is connected to the negative side of the battery, and the corresponding end of the right hand side of the resistance is connected to the positive side of the battery.

If the resistance of the left-hand is equal to that of the right-hand carbon pile there is no potential across the field winding of the booster to establish current through it. The drop through the 2 carbon pile resistances is equal to the total battery potential and if the 2 are equal, the drop from either side of the battery through either carbon pile is ½ the total drop, so that the end of the field winding of the booster connected to the upper ends of the carbon pile, is also at the potential of the middle point of the battery.

sistances. If the left hand resistance was zero and the right hand infinite, there would be current from the middle point of the battery through the field winding of the booster to the negative side. If the right hand

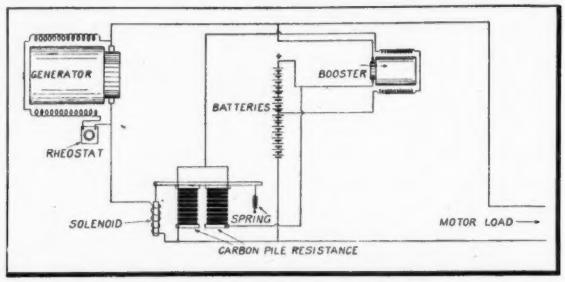


FIG. 9. EXTERNALLY CONTROLLED BOOSTER SYSTEM USING CARBON PILE RESISTANCES

carbon pile resistance was zero, and that of the left hand carbon pile infinite, there would be current from the positive side through the field winding of the

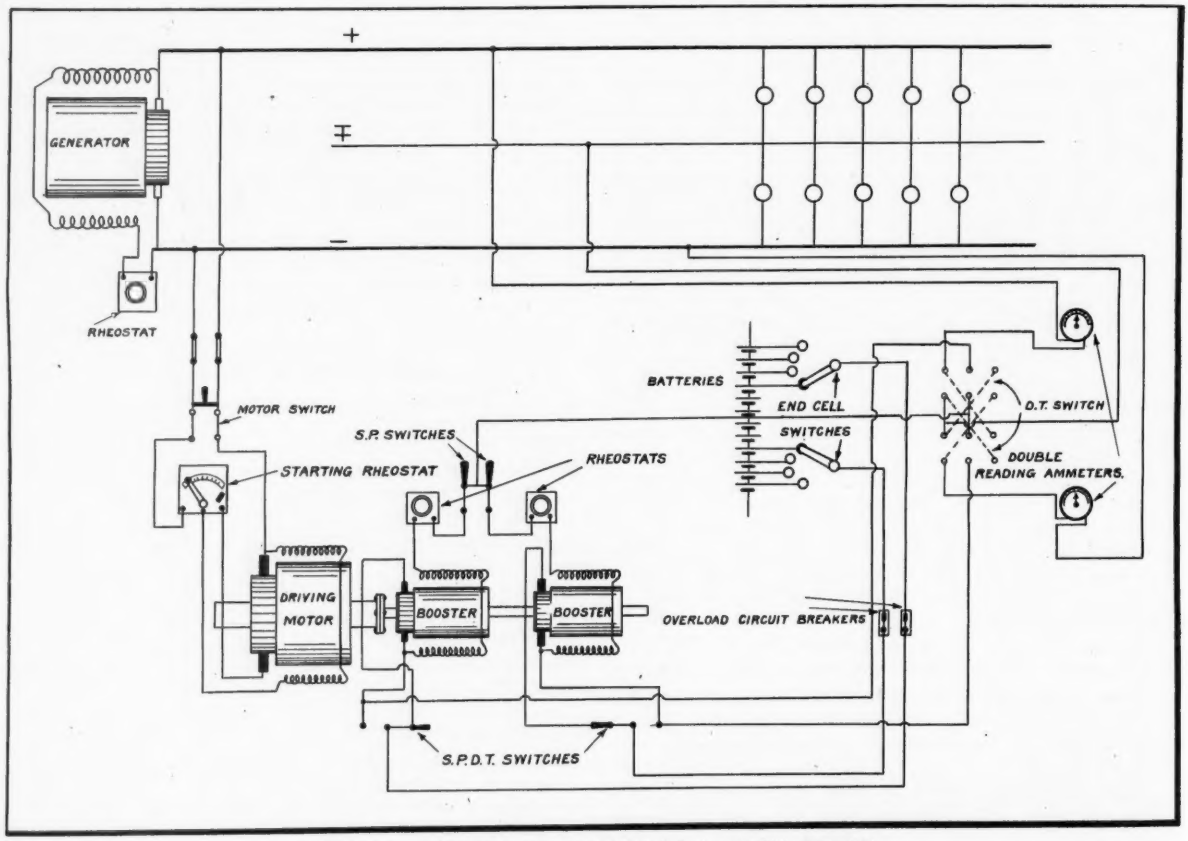


FIG. 11. BOOSTERS FOR EQUALIZING A 3-WIRE SYSTEM

If an inequality of these 2 resistances is produced, there will be current passing through the field winding of the booster. Its direction will depend on which of the resistances is the smaller, and its magnitude will be proportional to the differences between the 2 re-

booster to the middle point of the battery.

Variation in the pressure on a carbon pile causes variation in its resistance and the solenoid opposed by a spring, both pulling on the lever which rests on the two piles, controls the relative resistance causing charge and discharge of the battery. The solenoid

*Continued from page 314 of the March 15 issue.

magnet winding is in series with the generator current and when the load is normal the spring pull is just equal to the solenoid's. A small proportional variation in the pull of the solenoid changes the resistances of the piles and the booster field is energized, producing an e.m.f. to charge or discharge the battery.

A modification of this system of booster voltage control is shown in Fig. 10. It is similar in its operation but for the carbon pile resistances are substituted cups filled with mercury into which points attached to the lever dip. These points are connected to a resistance. The points vary in length so that when the lever tips either to one side or to the other the outside

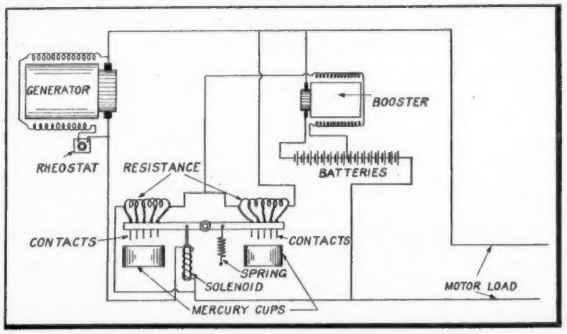


FIG. 10. MODIFICATION OF EXTERNAL CONTROL SYSTEM SHOWN IN FIG. 9.

contact is immersed first and then the others in succession, depending upon the distance which the lever is pulled downward.

Equalizer on a 3-Wire System

FIGURE 11 shows a storage battery connected to a 3-wire system, acting both as an equalizer and for power storage. There are an end cell switch and a booster at each end of the system, the kind of booster required depending on the character of the load. If the battery is to give regulation on fluctuating loads, some type of automatic booster which maintains the line voltage constant must be used. If the boosters are merely for charging, the ordinary shunt machine is suitable. If they are used reversibly, no end cells or end cell switches are required.

As will be seen by reference to the figure, the neutral wire is connected to the middle point of the battery where the double-throw switch closes in both directions. This is the fixed point to which the other leads must be referred, and the individual voltage of each side adjusted with reference to the neutral, not to the voltage, across the outside mains.

When the voltage on each side is correct, the voltage between the outside mains is also correct, but it is obvious that the voltage between outside mains might be normal and yet an inequality exist between 2 sides of the system. The single-pole, double-throw switches are for the purpose of connecting the battery to the line either direct or through the boosters. When the 4-pole double-throw switch is closed on the lower contacts, the left-hand half of the battery is connected across the positive and neutral lines, while the right hand half is connected across the neutral and negative lines. If one side of the system should be more heavily loaded than the other and therefore take more charge from its half of the battery, the switches may be closed on the upper contacts and each half of the battery transferred to the opposite side of the system.

ELECTRIC POWER FOR UNDERGROUND WINDING AND HAULING ENGINES

OWING partly to the great depth at which mining operations are now carried out, and partly to the distribution of the mineral, winding and haulage engines have frequently to be installed underground. Such engines range from the small single drum haulage used for pulling tubs up an incline, to the large double drum winding engines used in South African gold mines when the ore is being worked at too great a depth for hoisting to the surface in one stage.

During the early days of mining, hand winches were used for raising mineral in subsidiary underground shafts, while boys on ponies were, and in many cases still are, used to transport the material.

Only a short time elapsed between the introduction of electricity as a source of motive power and its application to haulage. Some mistakes were made at first, totally unsuitable motors and control gear were used, but still the results were not entirely unsatisfactory, and steady progress has been made, until today electricity is practically the only power to be ser-

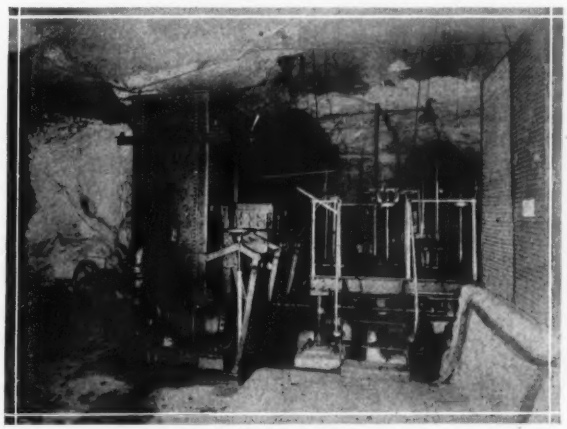


FIG. 1. CONTROLLER AND DRIVER'S PLATFORM, NEW HERIOT GOLD MINING COMPANY

iously considered by the majority of users of underground work.

Large field for underground electric winders is among the gold mines of South Africa, for it is there that the greatest developments have taken place in deep level mining. The final depths to which the gold mines will be carried can scarcely be predicted. Even now mines exceeding 4000 ft. in vertical depth are preparing to extend their operation for an additional 5000 ft. This of course entails winding in two or more stages since the limit of depth for one engine is in the neighborhood of 8000 ft.

Although not designed for such great depths, nor for an extremely great output, the underground electric hoist at the New Heriot Gold Mining Co., Ld., Denver, Transvaal, is very interesting. The service for which it was designed is:

Depth of shaft, 1080 ft.; incline, 45 deg. to horizontal; weight of rock, 5000 lb.; weight of skip, 3000 lb.; weight of rope 1840 lb.; maximum speed, 2000 ft. per min.

All parts of the hoist were designed to pass through an opening 7 ft. 8½ in. by 3 ft. 6 in. so as to permit

it to be taken underground and along a drive some half mile long. The headgear and ore bins are cut out of solid rock. The mechanical parts of the hoist, such as the drums, bedplate, gears, etc., were supplied by

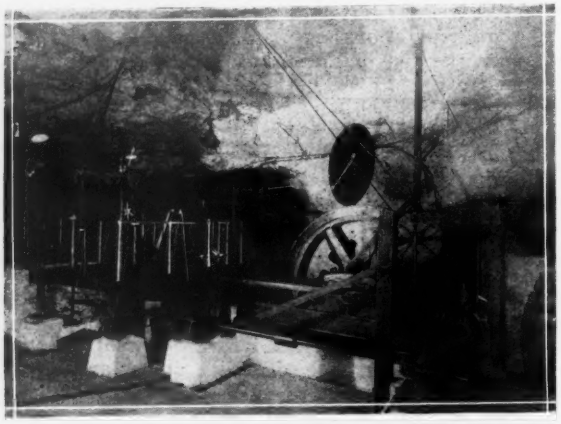


FIG. 2. GENERAL INTERIOR VIEW, NEW HERIOT GOLD MINING COMPANY

Messrs. Robey & Company, Limited, through the British Westinghouse Electric & Manufacturing Company, Limited, who supplied the entire electric equipment.

There are two winding drums, each 6 ft. diameter and 3 ft. wide, arranged in tandem but displaced sideways in relation to each other so as to obtain a good lead from the sheaves. The drums are driven through single reduction double helical cut gears of a ratio of

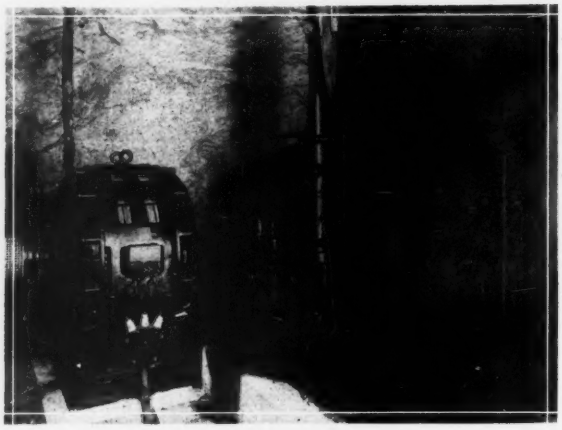


FIG 3. HOIST MOTOR, 500-HP., NEW HERIOT GOLD MINING COMPANY

approximately 3:4:1 by means of a 500-b.hp. (1250-hp. maximum), 2000 volt, 3-phase, 50-cycle, 375 r.p.m. slip ring induction motor.

The speed and direction of rotation of the motor are governed by a liquid controller. The controller is of the type usually supplied for winding engines, the resistence liquid being continually circulated over cooling coils by means of a small centrifugal pump, and the resistance in the rotor circuit varied by altering the depth of immersion of the iron electrodes connected to the slip rings. The reversal of the motor is accomplished by two independent three-pole oil switches, either one of which can be closed at a given time, but not both at the same time.

At the rear of the driver's platform is the main switchboard, equipped with an overload release oil circuit-breaker, with inverse time limit relay, an integrating watthour meter and an oil circuit-breaker for a small transformer, used to supply power at a low voltage to the small pump motor on the controller, and other auxiliary apparatus. The main oil circuit-breaker is arranged to be mechanically tripped from the emergency device seen in the front of the driver's platform, in case that device should for any reason fail to act.

The emergency device is designed to drop heavy weights automatically across the foot brake levers in the event of overwinding, failure of power supply, or any other contingency necessitating sudden and powerful braking. A lever is provided on the platform so that the driver can operate this emergency device should it be necessary.

While the hoist described is representative of the best modern practice, it is but one of many to be found in the South African gold fields, either in successful service or in course of erection.

EMERGENCY LIGHTING AND PLANT

Story of a Box Car Station, an Arc Light System and the Operation Thereof

By F. C. Barton

IN the ruins left by the flood which practically wiped the town of Austin, Pa., out of existence, were buried almost 80 human beings. The work of recovery was difficult and slow, even with the force of 1200 men which worked from early morning till dark. The most difficult problem lay in the searching of the ruins along

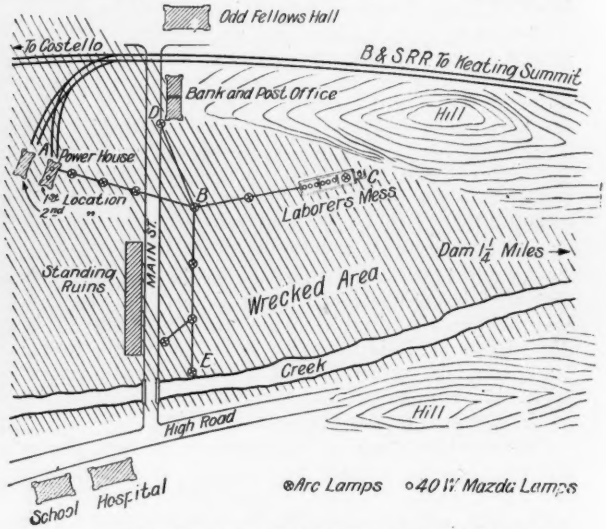


FIG. 1. WRECKED AREA SHOWING LOCATION OF THE POWER HOUSE

Main street, which ran crosswise of the valley. The brick buildings on the down-stream side, though badly damaged, withstood the impact of the flood, not because of their own strength, but by reason of the mass of brick, mortar and other non-floating debris thrown against them from across the street.

In the overhauling of this mass of wreckage, lay the greatest need for haste, for reasons of sanitation, if nothing else. When, therefore, the Health Department engineers realized that the task would take much longer

than originally contemplated, night work on a large scale was decided upon, and the offer made some days previously by the General Electric Co. was accepted.

Word was received in Schenectady by 'phone on Thursday, Oct. 5, that there was urgent need for night work, which could not be carried on without some satisfactory means of artificial illumination. Orders were immediately placed for apparatus, which included a standard 10-kw. gasoline-electric generating set, a standard motor-driven cooling radiator, a gasoline tank, 12 125-volt multiple enclosed arc lamps, 12 40-watt Mazda lamps, and 5000 ft. of No. 8 insulated wire. All of this apparatus left the factories the same evening. The same night the writer also left Schenectady, arriving at Costello about noon the following day. From Costello it was necessary to drive a distance of 3 miles over a much washed-out road up the valley to Austin.

An Erie box car, No. 75375, was appropriated for use as a power station, and placed on a siding adjacent to the express car in which the apparatus arrived. Labor being plentiful, the shifting of the gasoline set and other apparatus wanted in the box car was a simple matter, after which the car was pushed down a cleared stretch of track to the position shown in Fig. 1.

At noon on Saturday a construction man from the Philadelphia Office arrived to assist in the work, taking charge of the outside work, including pole lines and arc lamps, while the writer attended to setting up the plant. Certain difficulties were encountered in piping up the gasoline engine, because of the difficulty of securing pipe and fittings; but a brief search of the wreckage in the vicinity of the power house never failed to bring to light

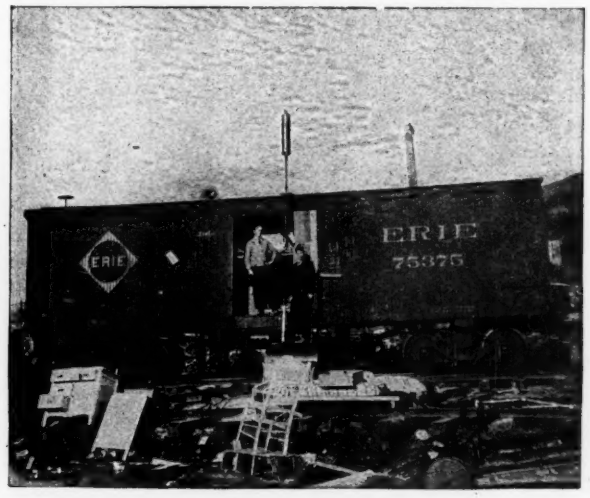


FIG. 2. EXTERIOR OF "POWER HOUSE"

the desired articles. The poles were composed entirely of lumber taken from the wreckage, insulators being noticeable for their absence.

On Sunday morning the system, including 8 arc lamps, was ready for operation, but up to that hour no gasoline had arrived. Having foreseen that there might be difficulty in obtaining gasoline, because of the reticence on the part of the transportation companies who handle this commodity, the writer had made a canvass of all the wrecked automobiles in the vicinity, and had located a supply which would have been sufficient to carry the plant through one night. When, therefore, everything was ready, 8 or 10 gallons of gasoline were drawn from one wrecked automobile and the system tried out.

During the afternoon a barrel of gasoline was brought into the power house in a special car, as a result of an appeal by the Commissioner to the Railroads. On Sunday night the plant was put in regular operation, and the electrical force, consisting of "the man from Philadelphia" and the writer, moved from the converted passenger car in which it had been sleeping, along with the engineers and 2 doctors of the Pennsylvania Department of Health, to "Erie, 75375 Railroad Avenue."

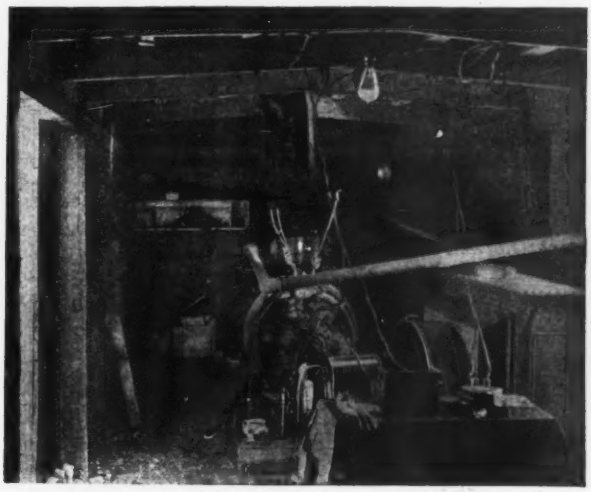


FIG. 3. INTERIOR OF STATION NO. 75375

On Monday a request was received to light electrically the laborers' mess, which is shown in Fig. 1, and to make certain other changes which added 3 arc lamps and 7 40-watt Mazda lamps to the equipment, making a total of 11 arc lamps and 9 incandescent lamps. In addition to this, the power house was moved and there were 2 more poles to set at the end of the line in consequence.

The power house crew worked normally a 24-hour shift, the daylight hours being spent in line construction made necessary by changes in conditions, and the night spent in running the plant, which meant going to bed and sleeping all night.

The plant was run without a single interruption each night from 5:45 in the evening until 6:45 in the morning, or as near to that time as the crew woke up. From the remarks of Dr. Dixon, his engineers and members of the Pennsylvania state constabulary, the writer gathered that the service rendered by the plant and lights amply justified its being. The state police are mentioned, as in their hands lay the policing of the entire district. This duty they performed most thoroughly; so much so that with the police in the day time, and the combination police and arc lights at night, a certain valueless souvenir desired by the writer was still reposing, when he left, in the position in which he first saw it. Somehow it seemed that the joke was on the man who made the place so bright he couldn't loot.

A glance at Fig. 1 will serve to show the distribution system. A single pair of No. 8 wires, carrying 3 arc lamps, was run to the distribution center B. From this point the circuit branched in the direction of the bank, the laborers' mess, and across Main street in front of the standing ruins. After the first night's operation it was found advisable to run a second pair of No. 8 wires, paralleling the first pair, from the power house to point B, in order to cut down the line drop. With this last addition the distribution was quite satisfactory.

LOZIER FIVE-TON TRUCK

Details of Construction and Novel Features

LOZIER trucks are rated at 5-ton normal load capacity with a 4-cylinder, 35-hp. motor. The loading platform is 12 ft. 8 in. in length, approximately 8 in. longer than the standard of the leading American trucks of this type. There are 2 general practices in truck designs, one placing the seat back of the motor as in touring cars and the other placing the seat over the motor. The Lozier is of the latter type. This arrangement in motor truck design is important as it effects loading, distribution, accessibility of parts, economy of operation, durability and general efficiency. Heretofore, it has been claimed that the motor under the bonnet was desirable as giving greater accessibility and this has been the reason given by builders of this type for this form of construction. In the Lozier truck, although the motor is placed under the seat, this seat is hinged in such a manner that it can be thrown back out of the way in

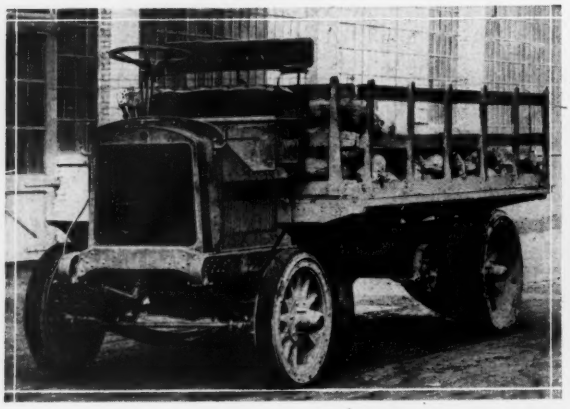


FIG. 1. LOZIER 5-TON TRUCK

a few moments' time or can be removed with 5 min. work. The cooler can be removed by loosening 2 nuts and removing 3 bolts, giving access to the motor from the front. Without disturbing either the seat or the cooler, all parts of the motor are as remarkably easy of access as in the touring car so that placing the seat back of the motor as a means of offering accessibility to the motor is not necessary in the case of the Lozier as it is designed.

Accessibility of all parts and means for quick repairs or replacements are most noticeable on the new Lozier truck. The motor, clutch and transmission are mounted on a complete sub-frame independent of the main frame. The sub-frame of the power plant is hinged at the rear end to a cross member of the frame, while the forward end rests on independent auxiliary springs. The removal of 4 bolts in front and 2 bolts at the rear enables the entire power plant, consisting of cooler, motor, clutch, transmission, steering wheel and driver's seat, to be taken from the chassis and in cases where a number of trucks are used by one concern, an extra power plant could be installed in 30 min. time, leaving the power plant removed to be repaired at leisure. This unit power plant contained in the sub-frame is divided into 2 parts, the motor group and the transmission, either of which may be quickly removed independently of the other, while the jackshaft to the rear of the transmission is also supported independently of the other units and may be removed without disturbing other parts of the chassis.

Valves are of nickel alloy and all located on one side. The crank shaft is mounted on 3 annular ball bearings and is unusually heavy. Cam shafts are driven by silent chains in oil-tight case instead of by gears. This is in accordance with the latest European practice, the chains eliminating noise and adding to the life of a quiet running motor. Lubrication is a combination of splash and force feed, the splash level being adjustable from the front end of the motor case. Oil is taken from the oil cellar in the crank case by a gear driven pump and distributed to the bearings and splash pockets, overflowing into the oil cellar through a strainer; the oil cellar has a capacity of 3 gal. The gage on the motor indicates the quantity of oil while the pressure gage on the dash indicates the action of the oil pump.

Bosch, dual system, battery and magneto ignition is employed, the magneto being located on the rear leg of the motor in an accessible position. The governor operates on a valve in the inlet manifold, separate from the carburetor, thus allowing the operator to remove the carburetor without disturbing the governing mechanism or breaking the governor seal so

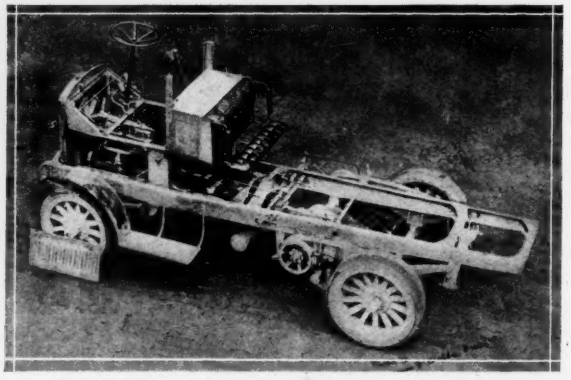


FIG. 2. CHASSIS LOZIER 5-TON TRUCK SHOWING ACCESSIBILITY OF MOTOR

that the driver is unable to tamper with the governor through any excuse. The advantage of a governor acting directly on motor speed over other forms is obvious; in the case of clutch governor sometimes used, this type of governor operates only when the clutch is thrown out, while the transmission governor does not prevent speeding of the motor in starting from the crank or when the clutch is thrown out while the truck is running. Truck drivers frequently crank the motor with the throttle wide open and before they reach their seats, the motor may be running at maximum speed, which, in time, results in injury to the motor.

Clutches are of the standard Lozier design with 28 hardened saw blade steel disks enclosed in oil-tight flywheel case. This construction permits of extreme flexibility in operation and minimizes strains on motor, transmission and tires. Power is transmitted from the clutch to the transmission through a double uni-

versal joint of the block type made of high carbon steel hardened and ground and enclosed in metallic dust-proof oil case.

Transmission gearing and the jackshaft is made up of 2 separate and distinct units. The transmission is of selective sliding gear type with 4 forward speeds and reverse, direct drive on third speed, and all shifts made by one lever. Gears and shafts are unusually heavy and made of chrome nickel steel, heat treated, and mounted on annular ball bearings. Double annular ball bearings are used to support the drive gear, one on each side of the gear preventing distortion and vibration. The center shaft is mounted on one annular ball bearing on the forward end of the shaft and 2 on the rear end; the final drive is through chains. Sprocket rims are bolted to the drum and may be removed for replacement. Gear ratios are arranged to give a speed of 10 miles per hr. on direct or third speed—when running light or on smooth level roads, or in smooth level countries on good state roads, the 4th speed gear may be used giving a speed of 13 miles per hr. The speed may be further increased by a re-arrangement of sprockets.

Chains and sprockets are enclosed in pressed steel chain cases made in halves and easily removable; they are both dust and oil tight. A large handhole plate is located in the upper half for purposes of inspection or as a means of filling the case with grease. A brass collar is carried on the jack shaft sprocket rotating in a large groove in the guard enabling the chain to be adjusted without disturbing the chain case.

The main frame is of high grade, channel section,

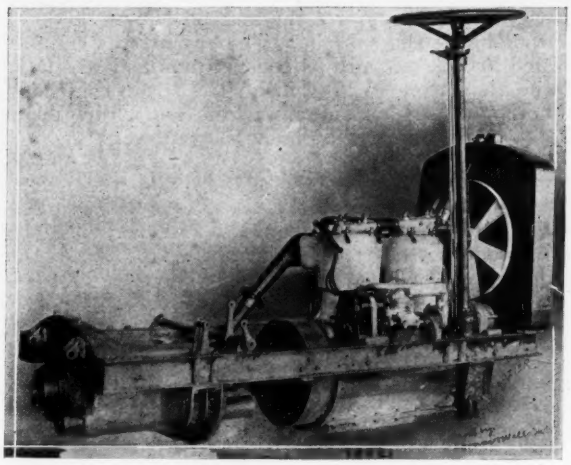


FIG. 3. RIGHT-HAND SIDE OF MOTOR SHOWING MAGNETO, GOVERNOR AND WATER PUMP

pressed steel, 8 in. deep and 2 in. wide, tapering from the motor to the front spring hanger. The frame also tapers in the rear from the jackshaft to the rear end of the frame where it is but 34 in. in width, thus allowing the rear springs to be placed outside of the frame, consequently lowering it to 34 in. from the ground.

The jackshaft is enclosed in pressed steel housings extending outward to the sprockets and is suspended from the frame by 2 split brackets. On the outer ends of the jackshaft housing is an adjustable cage which carries a roller bearing directly under the center of the sprocket. The outside of the cage is spherical in shape, thus forming a ball shaped member on which a split eccentric is mounted, this split eccentric forming the forward support for the radius rod. The eccentric meshes with a worm cut on a shaft which extends through the radius rod cap in a vertical position and the end of this shaft being squared, permits adjusting the radius rod by means of a wrench, loosening or tightening the chain as desired. The rear ends of the radius rods are supported by a king-bolt through a trunnion and bearing fitted to the rear axle. Torsional strains are obviated through the unique method of connections of the radius rod, front and rear, as either one of the rear wheels may be raised to any height without distortion of the radius rods, which perform a very important function in heavy duty trucks, have broken—not through a weakness of the rods themselves, but through failure to make proper allowances for torsional strains of this kind.

The drive shaft between the transmission and the jackshaft case is carried in a pressed steel torque tube,

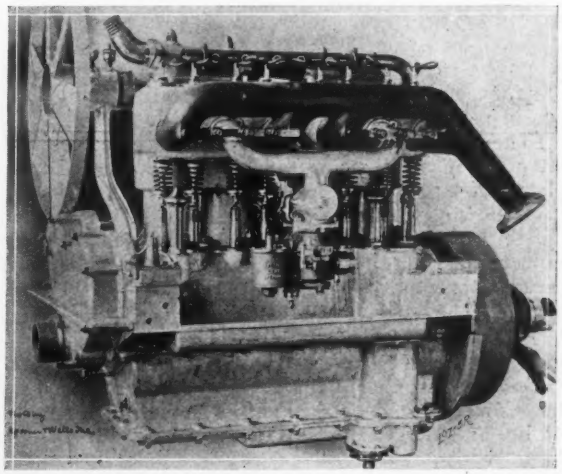


FIG. 4. LEFT-HAND SIDE OF MOTOR SHOWING CARBURETOR, EXHAUST AND INTAKE MANIFOLD

which is piloted over the jackshaft case at the rear, while on the front end, the torque tube carries a sliding sleeve, the forward end of which is spherical in shape and is carried in a housing on the rear of the transmission. This housing encloses the universal joint and transmission bearings, thus making an absolutely dust-proof and oil-tight case from the transmission to the jackshaft.

With the Lozier construction, it is possible to slip the torque tube out of the way by removing 6 bolts, allowing the front end of the drive shaft to be dropped down out of the way, the jackshaft being pivoted on the main frame brackets, thus permitting access to the transmission case from the rear or allowing the transmission case to be removed from the sub-frame without disturbing any of the parts of the jackshaft itself.

Service brakes are mounted on the jackshaft and are of the external contracting type, 14 in. in diameter by 2½ in. in width. The emergency brakes are of the internal expanding type enclosed in the rear wheel drum, 18 in. in diameter with 4-in. faces. All brakes have equalizers and hand adjustments. Rear sprockets are piloted over the rear brake drum to which they are

bolted, while the front sprockets are mounted on the tapered end of the jackshaft and secured by key and nut.

Front and rear axles are deep forged from high carbon, heat treated, open hearth steel of rectangular section 2½ by 3¾ in. On the front axle, the spring pads are carried below the center of the wheel, the axle having a drop of 5 inches, allowing the lower half of the motor case to be removed without interfering with the axle; also permitting the motor to be placed sufficiently low in the sub-frame to give a practically straight line drive from the motor to the rear wheel when the truck is loaded as the sub-frame is placed on an angle of one and one-half degrees.

Wheels are of the artillery type; are 36 by 5 in. front, 40 by 5 in. rear, all equipped with S. A. E. standard demountable tires, twin tires being used on rear wheels. The spokes on the rear wheels are offset, bringing the bearings near the spring pads and shortening the leverage or the axle. The advantage of using demountable rims is obvious as it is not necessary to send the truck to the repair shop to make replacements.

Practically every bearing, even where the slightest wear may result, is bushed and equipped with some form of lubrication and in case of wear, bushings may be pressed out and new ones inserted.

Specifications are as follows:

Motor, 35 horsepower; normal truck capacity, 5 ton; wheel base, 134 in.; loading platform, 12 ft. 8 in. by 6 in.; front wheel tread, 65 in.; rear wheel tread, 70 in.

POWER COSTS

Comparisons of Operating Expense of Small Units of Various Types

IT is gratifying to note that, at the present time, much attention is being paid to the subject of power plant economics. This important phase of plant operation while of the greatest importance has in many instances been neglected.

The cost of producing power, has received too little attention in small plants which is also true of many plants of larger size.

Following abstracts of papers read before a recent meeting of The American Society of Mechanical Engineers held at New Haven, Conn., give some interesting operating costs of small plants.

First paper on A Small Producer Gas Power Plant in a Woodworking Shop, by Albert W. Honywill, Jr., gave the cost of operation and working conditions, with a producer plant installed at the Lampson Lumber Company of New Haven. The engine is rated at 45 hp. at 160 r.p.m. and is of the 4-cycle hit-and-miss type, with poppet valves and jump-spark ignition. The producer is of the ordinary suction type, with stationary grates, and the quantity of gas delivered to the engine is varied by a hand-adjusted throttle valve in the delivery pipe. The plant is in operation 9 hr. a day, the engine kept running noon hour, and the load variable.

Average coal consumption is approximately 467 lb. of pea anthracite per day, or 46.7 lb. per hr. Assuming an average load factor for the shop of approximately 40 per cent, this is equivalent to 2½ lb. of coal per hp.-hr. The cost of coal delivered is $4.50 per ton, which would give an average cost per b.hp. per hr. of 0.56 cents. No account is taken of the cost of water, as the only cost is that of pumping.

First cost of the plant, including producer, engine, blower and motor to drive it, was, in round figures, $3500. The operating expenses per day were found to be:

Coal, 467 lb. at $4.50 per ton	$1.05
Labor	2.50
Repairs and depreciation	1.16
Interest and taxes	0.70
Oil and waste	0.14
	$5.55

Ashes from the producer were screened, however, and coal secured in this manner may be estimated at $2 per ton, which reduces the real operating expenses to $5.08 per day.

Following the paper by Mr. Honywill, there was a brief discussion, after which a paper was read by E. H. Lockwood, joint author with F. P. Pfleghar on Comparative Cost of Power by an Oil Engine and a Steam Engine. The cost of power of the following engines was compared: A De La Vergne oil engine, horizontal single-acting, center crank, 4-stroke cycle, jacket water-cooled; fuel, petroleum fuel oil at about 3 cents per gal. at the factory; ignition, hot chamber, on the Hornsby-Akroyd system; cylinder dimensions, diameter 27 in., stroke 33 in., rated horsepower 125, used to drive a direct-connected 220-volt generator, the power being used for light and power, and average output being about 90 hp. The engine was carefully tested for output and fuel consumption and was found to be quite economical of fuel. The steam engine was a horizontal 100-hp. Putnam engine, and a Fitzgibbons boiler of the same rated boiler horsepower.

Actual Cost of Operation of Oil Engine

Fuel oil, 14 gal. per day	$3.78
Labor, half-time of one man	1.50
Oil, waste, water, repairs, per day	1.00
Cost per day	$6.28

Reduced to the basis of 300 days per year, and divided by 90 (hp.), the above cost amounts to $20.93 per hp. per yr.

Fixed Charges for Same Engine

Cost of engine and generator, 10 per cent of $6000	$600.00
Cost of heating boiler, 10 per cent of $1000	100.00
Insurance, taxes, etc, per yr	250.00
Total fixed charges per yr	$950.00
Fixed charges per year per hp	10.55

Combining the two costs, the total cost per hp. per year, operation and fixed charges, is $30.48.

Estimated Cost of Operation of Steam Engine

Fuel per day, 2¼ tons	$8.21
Labor, time of one man	3.00
Oil, waste, etc., per day	0.50
Total per day	$11.71

Reduced to the basis of 300 days, and divided by 90 (hp.), the above cost amounts to $39.04 per hp. per year.

Fixed Charges for Same Engine

Cost of steam engine and generator, 10 per cent	$350.00
Cost of boiler, 10 per cent	200.00
Repairs, insurance, and taxes	250.00
Total fixed charges per yr.	$800.00
Fixed charges per year per hp.	8.88

Two costs combined give a total cost of 1 hp. per yr., operation and fixed charges, of $47.92.

This showing is favorable to the oil engine, but it must be remembered that the steam engine has a useful byproduct of exhaust steam during seven months of the yr. when the factory must be heated. Allowance can be made for the steam used in this way by deducting the cost of coal required for heating, which, estimated at 1 ton per day on the average for seven months, is about $766. By this credit the cost of power by the steam engine is reduced, but is still above the oil engine, as will be shown by the following summary:

Total cost of power by 90-hp. oil engine, including labor, fuel, fixed charges, etc.	$30.48
Total cost of power by 90-hp. steam engine, including labor, fuel, fixed charges, etc., and giving credit for exhaust steam for heating.	39.38

Both the above are on the basis of 1 hp. per day of 10 hr., 300 days per yr.

Following the paper by E. H. Lockwood, there was a discussion, after which a paper was read on The Status of Small Steam Turbines by W. J. A. London. He considered that the question of water rate does not cover the real meaning of efficiency; in a small turbine a difference of a few per cent in water rate efficiency means comparatively little as far as the cost of operation is concerned, and if higher water rate efficiency may be attained only at the cost of additional complication and weight, and higher first cost, he thought it would be a mistake always to prefer absolute water rate to commercial efficiency and especially reliability of operation. As regards the actual water rates obtained, the turbine is not a "steam hog," as shown by a few examples quoted below, but the engineer in practice is more interested in his overall water rate per air, electrical or water hp., as the case may be, and in this respect units are now obtainable which can hold their own against all competition, not only in reliability but in actual water rate efficiency. In general, however, where a guarantee made by the turbine builder apparently falls down in actual tests with a blower or pump, it is often found that the fault lies with the pump rather than with the turbine. With regard to the comparative performances of turbine-driven and engine-driven pumps for boiler-feed purposes, some interesting comparisons (Table 1) are obtainable from the tests made on board the scout cruisers Birmingham, Chester and Salem. Together with these figures are given the water rates that are obtainable from the modern turbine boiler-feed pump.

TABLE I. PERFORMANCE OF RECIPROCATING FEED PUMPS ON SCOUT CRUISERS AND EQUIVALENT PERFORMANCE OF TURBINE DRIVEN SETS

	Steam Pressure Lb.	Back Pressure Lb.	Gal. per Min.	Ft.	Water Rate	Equivalent Turbine Wat. Rate	Improvement Per Cent
Birmingham	183	6	329	488	83.0	61.8	25.5
Salem	203	6	193	690	91.8	61.2	33.6
Chester	187	6.7	219	610	101.0	64.0	34.6
Average					91.9	62.4	31.2

On reciprocating sets efficiency assumed: pump—85 per cent engine—90 per cent.

On the general subject of steam consumption of small steam turbines, the writer thinks that Napier's formula might be used to greater commercial advantage than it is at the present time. The majority of small turbines now operate with a terminal pressure at the jet below 0.58 of the initial pressure, so that this formula can be applied to any machine, and the steam consumption determined by placing a gage in the steam ring, the number and size of jets being known. In a series of tests carried out within the last few days, in seven readings with a ring pressure varying from 40 to 150 lb., the maximum discrepancy between calculated and actual results was 1.3 per cent and the mean over all the readings was 0.443 per cent.

The design of the machine should be as simple and the governor and other mechanism attached thereto as fool-proof as possible, even at the expense of efficiency, if necessary, and recent government tests have shown that the single governor mounted directly on the turbine shaft is sufficiently sensitive for close regulation.

ON DUTY

DEVOTION to duty is a prime requirement in an engineer, but fortunately, does not often call for the sacrifice demanded of Wesley Beaver, who operates in the municipal pumping station at Collinsville, Ill.

Responsible for the engines which kept up water supply to his community, he received a message, while on night watch that his wife was dying—only 5 blocks away. But the plant must run; it is the city's safeguard against fire, and he might not leave his post until a relief could be secured.

At that time, it was slow work rousing from the sleeping world a man competent to take his place, and 2 hr. went by after the telephone call came from his wife's sister, "Come home at once Wesley; Flora has a sudden heart stroke and the doctor says she is dying."

Finally the relief came; he might go, yet water pressure would be maintained, with a licensed engineer safely in charge.

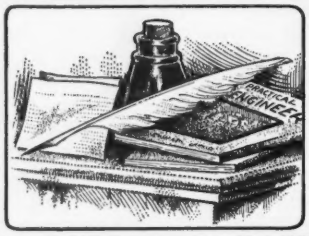
Blindly he started to run to his home, but the treacherous ice betrayed him, and a slip and fall into a ditch stunned him so that, for a time he could not move, though dimly feeling that some need was urging. Then he came to himself; he remembered, and staggering to his feet, hurried the short remaining distance. But too late; she to whom he had hastened, had outsped him and was on the long journey where he might not follow.

WATER POWER FOR PITTSBURGH

RUMORS that electric power from Niagara was to be furnished to Pittsburgh have been frequently denied, but another source seems to be in sight.

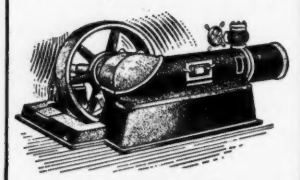
Charters have been applied for in 17 townships for power development companies, all to be controlled by one parent company, of which Joseph R. Paull is the moving spirit, to dam the Clarion and Tionesta rivers. Three dams are to be built to form a reservoir 52 miles long on the Clarion River at an expenditure of $10,000,000.

This will hold back mountain torrents for gradual release, thus preventing floods, and will store enough water to run about 100,000 hp. continuously. Supply of power will not, of course, be immediate, but the outlook is promising for beginning the development in the near future.



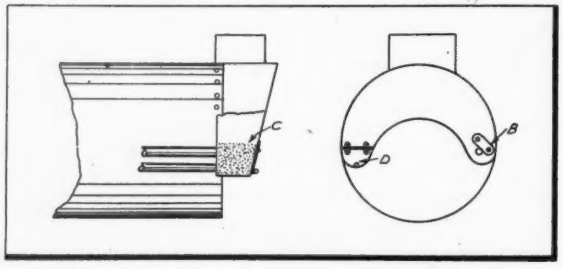
Letters from Engineers

Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings



CLEAN BREECHINGS

THE small things around our boiler sometimes are the ones that save as much in the way of fuel as well as protect the life of the boiler, and some of these small points in connection with our boilers are shown in the accompanying sketch. This is made from the marine type of internal furnace boiler. A section of one of the fronts of this kind of boiler is shown, and at C is an accumulation of soot and cinders that fall down and settle at this point in the breeching and



WHERE SOOT AND ASH SETTLE, AND THE REMEDY

by so doing cut off several of the flues, consequently lowering the steaming capacity of the boiler and by having a small door that can be opened without the opening of the entire front this portion of the boiler can be kept clean while the boiler is in full operation. I recently noticed an engineer who had a small hole about 1½ in. in diameter cut through this breeching and then had a small door for covering it. This was simply a small plate fastened by a rivet so that it could swing to the one side as shown but a better plan would be to have it arranged as shown at D in this way of cleaning could be done more easily and in less time. C. R. McGahey.

WATER IN RECEIVER

ON the night of Feb. 26th, at 2:30 a. m., in the power house of the Boston Elevated Railway, at Albany St., Boston, the cast-iron receiver exploded, creating havoc with the floor plates, scattering some of the pieces hanging them on the piping above. The first warning of trouble was given when the high-pressure cylinder began knocking badly, following this the receiver pressure began to rise and the relief valve blew very strongly and as the cutoff on the low-pressure is controlled by hand, the oiler who was tending this engine started to change the cutoff so that the low-pressure cylinder would take more steam and lower the receiver pressure.

While doing this a terrible noise was heard below the floor, the engine was immediately shut down and investigation showed that the receiver below the floor was cracked, a piece 2 ft. square broken out of the receiver head necessitated taking out the receiver and a long delay until another can be installed.

Although there are separators on the steam main, it is very evident that they were not capable of taking care of the water that might come over from flooded boilers. The bonnets on the high-pressure cylinder showed the effect of a dose of water as the packing around them showed leak marks, as also did the packing all around the high-pressure cylinder head. It is plain that some water got past the high-pressure cylinder without wrecking it, due, I think, to the steam valves lifting and relieving it, which of course would not have lasted long at this rate and after this water got into the receiver it got a water hammer.

The receiver pressure is usually 18 lb. and the relief valve blows at 24 lb. and was in good working order, as it is blown every day. Boiler pressure is 165 lb. The engine is rated at 1600 hp. S. Bolt.

SUBSTITUTE FOR PIPE VISE

WHEN no pipe vise is at hand especially suitable for smaller size pipes the writer has found a convenient substitute by sawing a nut in two as shown at Fig.

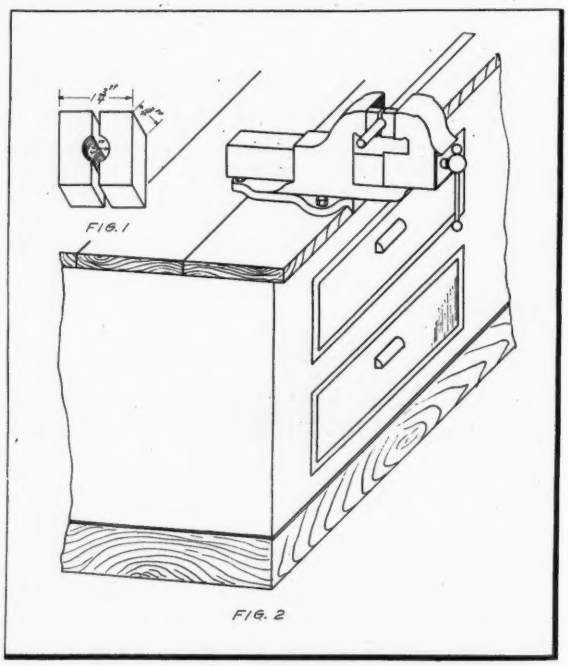


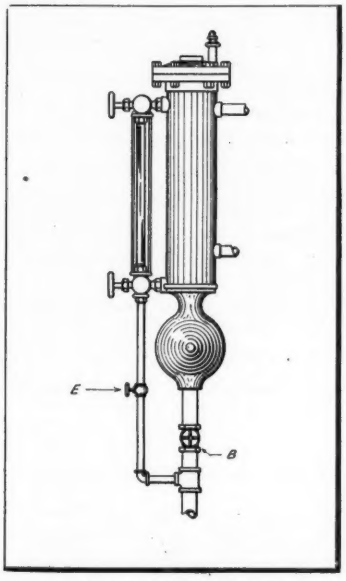
FIG. I. NUT SAWED FOR USE IN VISE

FIG. 2. USE OF NUT TO HOLD PIPE IN VISE

1. At Fig. 2 is shown its usefulness in the ordinary vise. Jas. G. Sheridan.

ALARM WATER COLUMN PIPING

PROPER arrangement of our alarm water columns is very much over looked. The accompanying sketch shows a convenient and careful arrangement. In the main drain pipe from the sediment chamber we have inserted a tee; and by having a blowoff pipe connected to the bottom of the water gage and this connected to the tee, which is placed in the main drain pipe below the stop valve from the waste of the column, the valve can be opened to blow down the gage glass without making a stop in the boiler room.



ALARM WATER COLUMN

Another good arrangement is a crank placed on the main globe valve, if the pump throws the water too high and causes the alarm to sound. This crank valve can be opened quickly and lower the water, stopping the valve from sounding the whistle; as a whole it makes a very good arrangement.

C. R. McGahey.

Is it advisable to prevent the whistle from sounding when the water level gets too high? (Editors.)

ENGINE ADJUSTMENT AND TESTS

EVERY engineer should take a certain amount of pride in having his plant in a good condition, but this pride is a valueless asset if it is not accompanied by thoughtful and intelligent work.

When an engine needs packing around the piston rod that is put in newly every week and has to have the wrist brasses adjusted as often, so that the engine will pass the "Old Man's" inspection, the man in charge should work a little overtime even if he is getting paid by the month.

There are several defects which will cause an engine to pound and heat in the wrist or cross-head that can not be corrected by taking up the brasses and leakage around the piston rod is not always stopped by putting new packing in the stuffing box.

If an engine continues to pound and heat in the wrist or cross-head when the brasses are properly adjusted, the trouble may be due to one or more of the following defects: The engine may be out of line; the crank pin or the cross-head pin may be worn out of round, or the crank pin may not be in line with the main shaft of the engine, due to a hard jar from water being caught in the cylinder.

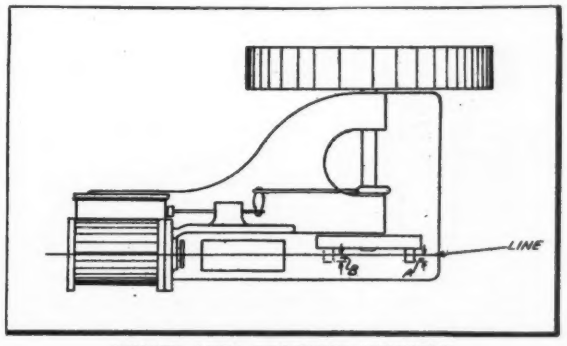
These faults are easily found and in some cases as easily corrected.

If it is thought that the cross-head pin or crank pin is worn out of round, they can be tested with a pair of calipers after the connecting rod has been taken off. To test for alignment between the crank pin and main shaft, first level up the main shaft, then the crank pin should show up level at every point of revolution of the crank. A fine spirit level should be used to get satisfactory results. If it is found that the crank pin is out of round or out of line it is best to have it turned down true.

An engine may get out of line from stresses developed in the engine frame, from wrong adjustment of the main bearings, a poor job of babbitting or unequal wear in the main bearings caused by a heavy belt pull.

To line up the engine take off the cylinder head and connecting rod, then pull out the piston and piston rod and cross head. Run a fine line through the cylinder and stuffing box and fasten it beyond the crank. Carefully center the line with the bore of the cylinder and stuffing box as shown in the sketch. The line can be centered with calipers or, better still, by an accurately made X in both cylinder and stuffing box.

When the line has been carefully placed put the crank on one center and measure the distance from the end of the crank pin to the line. Revolve the crank to the other center and measure the distance again. These 2 distances, A and B on the sketch,



CENTER LINE THROUGH CYLINDER

will be equal if the engine is in line and the work has been carefully done. If the engine is found to be out of line the shaft can be brought to its proper position by adjusting the quarter boxes. The belt should be left on during the test and the engine turned over by using levers or chain falls if necessary.

When an engine leaks around the piston rod and the leakage cannot be stopped by a reasonable amount of packing, it may be due to the travel of the piston not being parallel to the guides. In a horizontal engine when the bottom of the cylinder wears down the piston drops a small amount. If the shoes on the cross-head are not adjusted properly this wear causes the rod to have a slight vertical motion in addition to its horizontal motion which rapidly cuts out the packing. On taking up the wear in the cross-head shoes a poor adjustment of the shoes would cause the same trouble. To remedy this defect put the crank on the crank center so that as much of the piston rod is out of the stuffing box as is convenient, caliper between the rod and one guide and adjust the shoes until the piston rod is the same distance from the guides throughout its length.

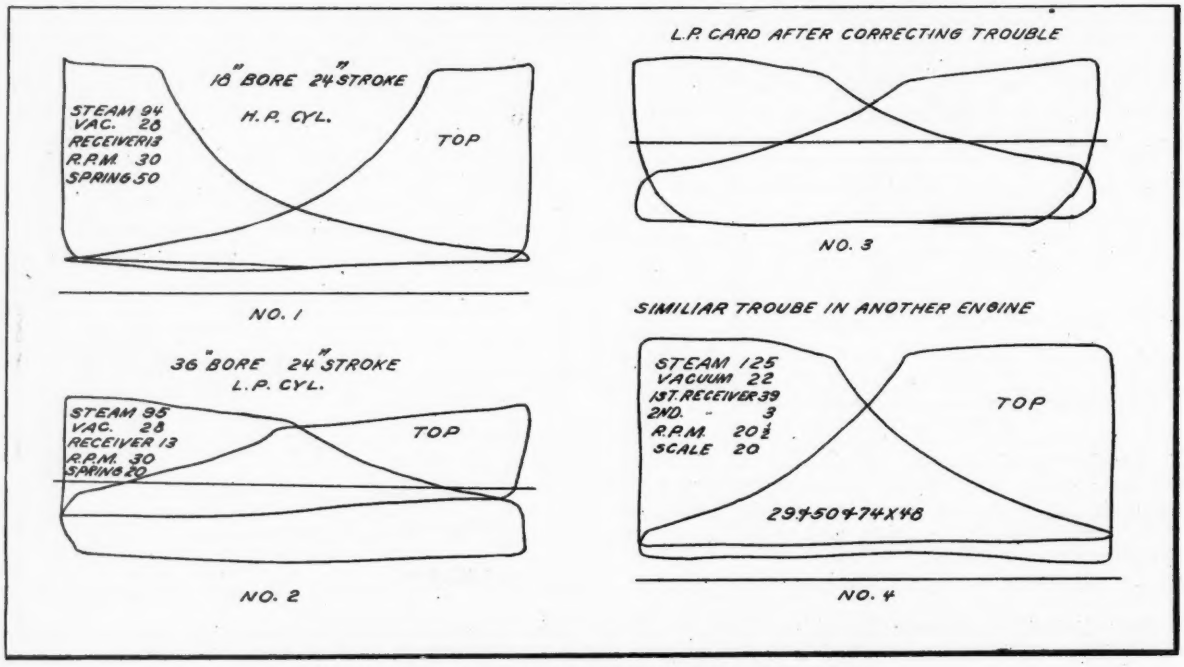
C. A. Gilson.

CHARACTERISTIC BUT PERPLEXING DIAGRAMS

ENCLOSED is a set of 4 diagrams; Nos. 1 and 2 were from a vertical compound pumping engine, No. 3 shows the changed appearance of the low-pressure diagram after the trouble was located and corrected, No. 4 shows a similar trouble in the intermediate cylinder of a triple expansion pumping engine.

An explanation of the cause of the excessive back pressure shown in No. 2 will be simple enough to one who has had experience with this specific form of trouble, but being a new experience, it puzzled a practical indicator man and a whole erecting force for some time. The same crew was not long, subsequently, in locating the cause of a similar trouble as shown in No. 4.

It will be interesting to note how the readers would explain the trouble and if any could hit upon the exact cause. F. C. Holly.



DIAGRAMS FROM A VERTICAL COMPOUND PUMPING ENGINE

PROPER EXAMINATIONS

THE many questions that are asked before license boards are very good, as they give one a chance to think of something that would not have come to mind before, but still there is another way of taking it, for instance, how much should a man know of a subject and how to express it before he can be able to pass an examination, for in some cases where engineers are classed, and the law says a man shall be graded to fitness, it works badly. A man may spend 5 or 6 yr. in heating, and know little or nothing of power plant machinery, but still he is expected to be able to go in green and make good, or from the power plant to hoisting. I think this is too much for a man to try to carry, and besides there is always the danger of trying to acquire a knowledge of too many lines to make good in any one.

To illustrate this, take the case of a man in Massachusetts, who had worked at oiling in a power plant 2 yr., when he was examined and got a third class license. He then became assistant in a hotel for 4 yr. While here he tried 7 times for a second class license, and 2 of which were before a board, and in each case the reason for failure was not enough experience, or not being able to answer satisfactorily.

I looked a set of questions over and think they could be improved upon. They are by no means hard, nor are they practical. The set follows:

In a modern plant, a battery of 6 boilers is being worked hard and the feed valve stem breaks with the valve closed. What should be done? The boiler can't be cut out.

If a set of new tubes for a boiler came ⅛ to ¼ in. short, what is to be done?

How would a crack between the outer and inner rows of rivets on a double strap joint be repaired to make the joint the same strength?

What are the pitch and size of rivets in a patch 10 in. square in the furnace sheet of this boiler?

What size braces and number in a 60-in. tubular, pressure 125 lb.; what size safety valve?

What happens when the rods from the wristplate of a Corliss engine work loose?

If new valves were put in this type of engine, and you know that they are tight and adjusted to work, still there is an extra amount of steam in the cylinder, what is the cause?

How can we tell the stem of the exhaust valve is bent without taking it out?

If the babbitt in the pillow block of a horizontal engine came out, how would you get it back without taking the shaft out?

How could the vacuum be kept up if engines are added without changing the size of exhaust, until with full load it began to fall?

What changes are made when putting another eccentric on a Corliss engine? Explain in full valve position.

How would you know an air bound condenser, and what would you do with it?

We wish to change a throttle governed engine to an automatic; what shall be gained and where shall the governor be keyed to the engine shaft?

What kind of valves and machinery would be in a plant laid out for vacuum heating? What in an exhaust system?

How is the point of compression regulated in 4-valve engines?

What would you do if called upon to start a cross-compound condensing engine and there was no gage to go by?

Then there are some questions on indicators, and I think any man that can answer the questions in 2 hr., which was the time allowed, and has had the experience of the man in question, ought to pass. What do the readers think?

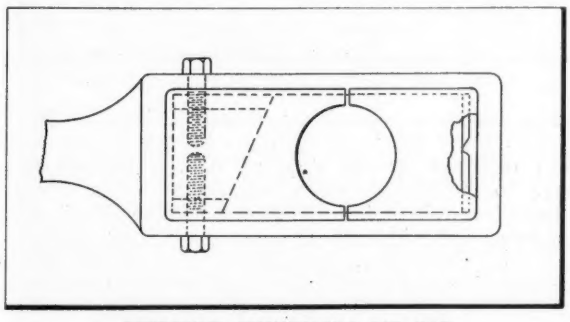
D. F. C.

HUMP CAUSED POUND

IT was a 17 and 34 by 42-in. engine, running at 104 r.p.m. and developing about 400 i.hp., and ran from Monday morning until the next Sunday morning. When the engine was first started after erecting, it had a slight pound, but the load was light and the connections were taken up 2 or 3 times a week, so the erecting engineer got by all right.

But when more load came on, the engine pounded hard and the hunt began, and no matter where one listened, the pound seemed to be there.

Engineers from other plants gave their opinions,



DEFECTIVE CONNECTING ROD END

and their ideas were all tried out, but with no beneficial results.

One Sunday I disconnected the connecting rod from the cross-head, and found on the inside of the strap a hump in the steel, as shown in the sketch.

I smoothed the hump off, which was about ⅛ in. high, connected the rod and when I started, Monday morning, the pound was gone.

I cut the hump off about a year ago and the engine has not pounded since. R. A. Hafford.

IS SMOKE A SIGN OF A HOT FIRE?

THE other day a so-called fireman came into the plant and said "what's the matter with your fire? There is no smoke." I replied "Then there is nothing the matter. There is lots of heat." "Well! I like a stack full of smoke; then I know she is steaming O. K.," was the comment.

I fire the front half of the grates with green coal on a thin bed of incandescent coals. Between firings or after every second firing, I work the coke back with the "devil's hoe" and let the coals in front get white hot. The bed of coals cokes the green coal and the gases are ignited by the burning coke at the back of the grate. This system causes very little smoke and will keep the "pop" guessing. L. N. Bexten.

DAILY METER READINGS

SOME time ago I had trouble getting correct meter readings. To avoid mistakes, by noting the reading on a piece of paper and transferring to the note desk, I had the accompanying form made, and let the operators

CHARLOTTE ELECTRIC RAILWAY CO
DAILY METER READINGS

Time of Reading ___ A.M. ___ P.M. Charlotte N.C. _____ 191

		KILOWATT HOURS	REMARKS
ENGINE 1		00	
ENGINE 2		00	
ROTARY 1		00	
ROTARY 2		00	
ROTARY 3		00	
A.C. POWER CIRCUIT 1		00	
A.C. POWER CIRCUIT 2		00	
STATION LIGHTS		00	
CIRCULATING PUMPS		00	
EXCITER 1		00	

FORM FOR RECORDING METER READING

read each meter by marking the dials. I have since had no trouble in hunting mistakes. By binding the daily sheets, it is easy to refer to any reading. J. B. Linker.

BURSTING PRESSURE OF BOILER

I THINK John Mitchell, in Practical Engineer for February 15, under Answer to Practical License Questions, is mistaken on question 3. The question and answer he gives are as follows:

Q. What pressure in pounds tends to render asunder from end to end a boiler 18 ft. by 72 in. at 100 lb. gage.

A. $P = p \times d \times l$

when P = total pressure tending to render asunder.
p = boiler pressure or 100 lb.
d = diameter of boiler or 72 in.
l = length of boiler in inches or $18 \times 12 = 216$ in.
$P = 100 \times 72 \times 216 = 1{,}555{,}200$ lb.

My solution of example as stated would be as follows:

$P = p \times a$

when p = pressure on boiler or 100 lb.
a = area in square inches of end of boiler.
P = total pressure tending to rend asunder.
$72 \times 72 \times .7854 = 4071.5$ sq. in.
$4071.5 \times 100 = 407{,}150$ lb.

The length of boiler has nothing whatever to do with pressure upon the ends as a boiler one inch long would have the same number of pounds on end as one 100 ft. long. C. E. Aldrich.

SPRING FOR DASHPOT ROD

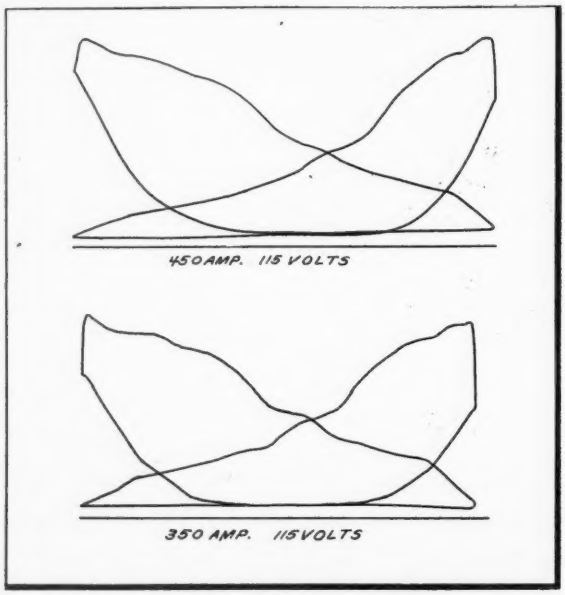
ON page 204 of the issue for Feb. 15, 1912, is a scheme used by Martin McGerry in case of a broken dashpot rod.

How does he keep the valve rod from turning around so that it could not be caught by the valve catch, or in other words how does he prevent the valve from having too much lap?

Possibly my idea of a Corliss valve construction is wrong, since I am not an engineer, but am just learning the trade and I do not want to be mistaken on a point like this. H. M. H.

CARDS FROM AUTOMATIC ENGINES

I AM sending a couple of diagrams which I took from my 2 engines, and would like to have them published to see what other engineers have to say about them;



CARDS FROM 2 BALL ENGINES

would like to know if I could make any improvements on them. They are Ball engines with automatic governors, a regular Ball valve, and run at 275 r.p.m. A. Mercer.

CERTAIN (?) GUIDES

IN A RIVER belt plant a comfortably indifferent darkey was found industriously watching a boiler which did not seem to comply with all the rules of the insurance companies. No water column was visible, nor any safety valve. Questioned as to how he knew when pressure got too high "Demostheens," as he defined himself, said: "Ah watches dot clock up front, an' when she gets up to 12 o'clock, ah knows ah done bettah haul out dat fire."

"But how do you know whether the water is right?"

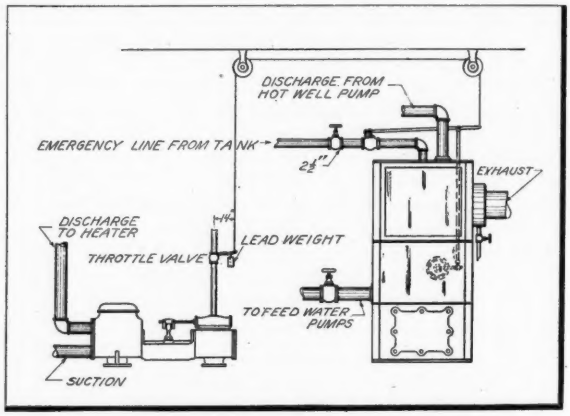
"You see dat ar ribet up dar? Wal when she stahts blowin' steam right good eroun dat, ah stahts de pump. An' ah lets her run til de water runs out fum roun' dat ribet right smaht. Den ah shuts her down agin."

AUTOMATIC HOT WELL PUMP CONTROL

AT the plant where I am employed we have as part of the equipment an open feed-water heater as shown by the sketch. It received the water through the 2½-in. line at the top, the flow being controlled by a valve operated by a float as shown.

Later a hot well was put in and a pump installed to pump the water into the heater. As the make up water was delivered to the hot well, the new pump handled all the water used, which cut out the 2½-in. line with the automatic feed.

Any engineer knows what it is to operate pumps by hand so that one will pump into a heater at the same rate as another will take it out and feed to the boilers. The firemen did it for 2 days of 12-hr. shifts, but as the hot well pump was some distance from the heater it was a tiresome job and not so safe as it might be, for sometimes the water would get too low in the



AUTOMATIC PUMP CONTROLLING SYSTEM

heater and there was plenty of trouble for a while.

To remedy the trouble I ran a light wire from the lever operated by the float up over 2 pulleys and down to the throttle valve on the pump as shown, using a lever about 14 in. long at the valve wheel. On the outer end of the lever I hung a weight made of lead which was heavy enough to operate the valve, the wire line was carried well up above the pipe work where it is out of the way. By connecting in this manner, the pump is automatically controlled without changing the other connections, so that in case the pump fails or is shut down for any reason, it is only necessary to open the gate valve in the 2½-in. emergency line and unhook the wire from the valve lever and the water is taken direct from the tank, the flow still being under control of the float.

This has been in continuous operation, except when cleaning the heater, for over 6 months and the water level never varies more than 2 in. in the heater.

B. F. Hartley.

IN OUR ISSUE OF FEB. 15, in referring to metallic packings, we made the following statement: "The Walker type is that composed of inverted snap rings held on by garter springs and working in a cage. Originally made under 'Walker' patents now expired, and now made by France Packing Co., and others."

This statement has been understood by some to mean that the France Packing Co. is manufacturing under patents that have expired. We are very glad to correct this misunderstanding. The France Packing Company's patents are still in force. Their patents cover an improvement on the original "Walker" packing by cutting the abutting ends of the ring sectors by a plane that is tangential to a circumference larger than that of the rod, instead of by a radial plane. The improvement prevents any possible leakage even though the packing be almost entirely worn out. The drawing shown in our issue of Feb. 15 was made from a France packing.

A TEMPORARY SLIDE RULE

An Expedient to Test What it Can Do to Help You In Making Calculations

By Ernest J. Beattie

REFERRING to the article on the slide rule by Richard Howarth in the Jan. 15 issue of Practical Engineer, it seems to me that any engineer who has occasion to delve into mathematics to any greater extent than the simple calculation of his overtime from week to week requires, should, for his own good, master at least the simpler slide rule processes.

To the average engineer, the name slide rule, is either a sort of "bugbear" or else it appeals to him as a refinement in the art of engineering to be classed with the wearing of kid gloves by his coal-wheeler.

Being of an indolent disposition, the slide rule appealed to me from the first time I saw one used, and

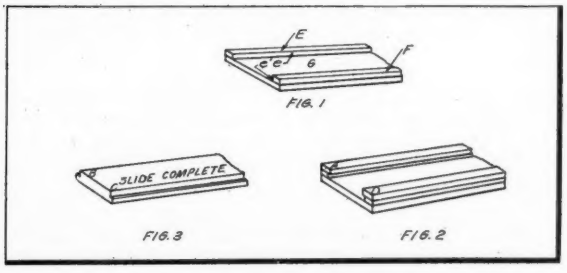


FIG. 1. FIRST STEP IN ASSEMBLING SLIDE RULE
FIG. 2. BODY OF RULE COMPLETE
FIG. 3. COMPLETED SLIDE

now if I had to go back to the old process of covering one side and both ends of the boiler room with figures to solve some ordinary, everyday brain racking problem, I should feel inclined to give up the business.

A good 12-in. "slip stick" will do about everything for you except oil up and bring your dinner and when once one becomes familiar with its operation the everyday calculations necessary to check the performances of an extensive up-to-date plant take less of your time than you used to devote to hunting up the pencil that the time keeper borrowed as he passed through, or the block of paper that the oiler used up in his endeavors to become a second Steinmetz.

As Mr. Howarth says, the only way to become proficient in the use of a slide rule is to get one and practice, but as a good K & E rule costs $5.00, the average engineer will not readily separate himself from this amount of the "hard earned" except that he is convinced that he will be able to use the rule after he gets it. But, on the other hand, let the would-be slide rule student follow these instructions and almost before he knows it he will have found out the possibilities of the rule and will supply himself with one of a first class make and live happily forever after.

First, turn to page 65 of Practical Engineer for Jan. 15, and cut out the picture of a slide rule that you find there, and glue or paste it smoothly on to a good flat piece of cardboard about 2 by 10 in. Next with a sharp knife cut out the slide using a straight edge of some kind. Now we are ready to assemble the rule.

Cut a piece of cardboard the width of the rule and say 8½ in. long, G Fig. 1, and on it glue the 2 strips E and F being careful to get edges e and e parallel. Now cut a piece of cardboard 9 in. long and just wide enough to slide easily on G between edges e and e of strips E and F, and when you get this fitted so that it slides all right, leave it in position between E and F while you glue scales A and D in position on strips E and F Fig. 2, using slide as a distance piece to keep edges of A and D parallel. Now glue the slide to the 9-in. piece of cardboard and be sure that it will slide easily and by trimming up the ends of rule and slide and going over the edges with very fine sandpaper you will have a slide rule which will enable you to follow Mr. Howarth in his series of articles, and also practice many of the less difficult every-day problems, checking your figures with pencil and paper until you get the "hang" of it.

I made a rule from my copy of Practical Engineer and enclose it with this letter, so that the staff may see just how it is made and make it plain to the bunch of live engineers who read this paper.

The paper model slide rule sent in by Mr. Beattie is very well made and will serve nicely the purpose for which he recommends it, of enabling the reader to get a beginning idea of what the slide rule can do for him in the way of saving time. It works nicely, reads with reasonable accuracy and will make a good starting instrument. Of course, part of the graduations are blocked out by the cut of the runner and no runner is available on the rule, but it will be a most interesting and helpful tool for the first 2 or 3 months' study. Editors.

DESIGNING OIL ENGINE PORTS

IN a recent discussion regarding oil engine ports Mr. Wolcott Remington, designer of the 2-cycle Blanchard oil engine, stated that in this type of oil engine the height of the exhaust port should be about 1/7 the stroke of the engine. This, of course, is only general for average speed because the piston speed or the number of revolutions per minute of the engine would have to be taken into consideration in getting at the height of the exhaust port.

For average speed the height of the inlet port would be about ½ the height of the exhaust port. This is necessary in order to give the exhaust gases sufficient time to escape from the cylinder before the new charge of air starts to enter. These proportions are based on the supposition that the average charge of air will enter at about 5 lb. pressure.

IN THE MANUFACTURE of its heavy hydraulic machinery, The Watson Stillman Co., has occasion to carry pressures as high as 10,000 lb. per sq. in. It has been found advisable to adopt vanadium bronze for this purpose and Mr. C. Wigtell, Chief Engineer of the Watson Stillman Co., gives interesting details of a test as follows: A tube of the material with an inside diameter of 1¼ in. and an outside diameter of 1.408 in. with a length of 4 in. was tested at 10,000 lb. per sq. in. under which pressure the tube stretched to an outside diameter of 1.422 in. giving a stress in the walls of the tube of 41,500 lb. per sq. in. of metal. The hydraulic pressure was then increased to 13,000 lb. per sq. in. under which pressure the tube stretched to 1.467 in. diameter putting a tensile stress of 53,600 lb. per sq. in. on the metal. Under both tests not a drop of water leaked through the metal and it is likely that if means had been available for producing a still higher pressure, the tube would have been good for it.

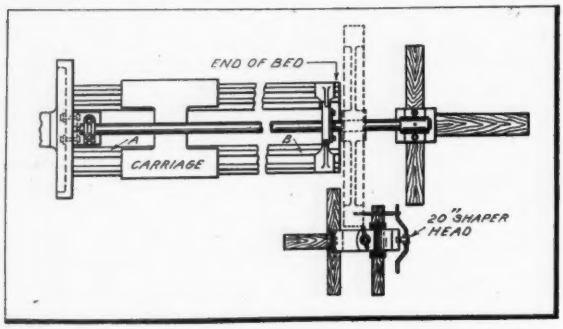
SUCCESSFUL KINKS

FOR SAVING TIME, WORK AND TROUBLE

A Lathe Job

WHILE the idea shown in the sketch is not so very new, it may be of value in rigging up for repair jobs. The job shown is a balance wheel for a stationary gas engine, and was to be faced, and turned, in order to make it run true. The wheel was about 36 in. diameter and 4 in. face. The bore is 2 in. Now this job, or any other like it, may be turned on a 24-in. lathe, very easily, and satisfactorily, in the manner herein described.

We removed the tailstock, and set a center rest as near the foot of the bed as possible. A small angle plate was bolted to the faceplate, as shown. This angle plate was set 1 in. below the live center, so that a piece of 2-in. shafting could be bolted to it, and remain in line with the center. We might have used a chuck, but a faceplate was on the lathe head, and an angle plate was on the floor, under the lathe, so we used that.



ARRANGEMENT OF LATHE TO TURN FLYWHEEL WITH TEMPORARY FACING RIG

A length of 2-in. shafting, 8 ft. long, and centered in one end, was "planed out" for the key, then was swung up into the center rest, and the centered end swung up on the live center, and clamped firmly to the angle plate, using a horseshoe clamp. Then, with a pair of inside calipers, the distance was measured from A, and then from B, to get the shafting parallel with the ways, and the center rest adjusted.

Out at the end of the shafting, a length of 8 by 8-in. timber was set up, and braced in 3 directions, as shown; the height, of course, being equal to the distance from the live center to the floor, minus the thickness of the pillow-block shown measured from the lower side of bore to the base. This need not, however, be an exact measurement. Locate the pillow block and bore holes for lag screws.

The balance wheel was then keyed on, and the pillow block put in place and bolted down. A ¾-in. hole had been drilled about 1¾-in. deep, and in this hole an 18-in. rod was securely driven. An old shaper head was used to carry the tool; the handle being taken off, and a disk fitted on. The disk carried rods, which, in this case it was necessary to bend, in a vise, as shown. The turning balance wheel, brought the 18-in. pin in contact with the bent rods, and, of course, fed the tool along; the amount of feed being governed by the length of the bent rods.

The shaper head was set, and braced, as shown.

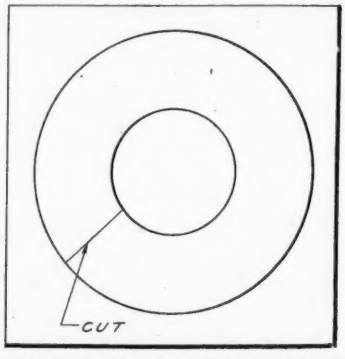
When we came to facing up, the shaperhead was turned ¼ way around, braced all over again, and was fed by hand. The 18-in. pin, that was driven in the balance wheel was nicked and broken off. In setting up the shaper head for facing, a piece of timber was run clear through under the shafting, just low enough to clear the key carried by the shafting. This saved much time when we came to setting the shaper head the third time; to face up the hub, since we had only to loosen up the clamps and move the shaper head to its new position, locate and bore the 3 holes, for stud, screw stop and bolt, and clamp the shaper head down again.

The key might be in the way sometimes, but not here; it was softer than the cutting tool. The chief sources of trouble in doing this sort of work are that the lathe will only pull a very light cut, and it is not at all difficult to burn the tool, since one can not obtain the proper speed, for work of this diameter. Needless to say, this job was done at a loss; one of those unwelcome jobs that must be done to hold trade.

Chips.

Piston Packing

TO make some packing I took some heavy rubber belting, and with a washer cutter cut out washers the size of my piston and stuffing box, and then cut the washer open to make a lap joint, as shown in the illustration. I then put the washers in warm cylinder oil for a few minutes before inserting them in the stuffing box, and afterward tightened up the nuts with



SHOWING HOW PACKING WAS OUT

my fingers. The rings will swell quite a little and care should be taken not to bring the gland up too tight, as it is liable to crease the rod. This form of packing works well on creased rods and I have run some on a steam pump night and day for 4 months.

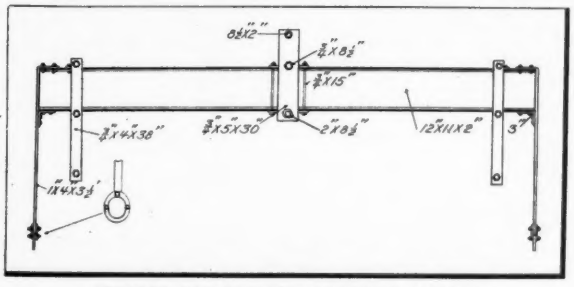
G. M. Brooks.

Device For Lifting Turbine Covers

WE have 4 turbines of Westinghouse-Parson type in our station, and for local reasons we have found it advisable to inspect them at certain intervals. Desiring to make the work light, quick and easy, a device was made from some material lying around the plant. The advantage we have found for this device over the one which came with the machines is that, when once adjusted and positions are marked on the beam, you always have a balance. The spreader which came with machines must be changed each time the cover and spindle are raised and lowered, and these

changes are made by using turn buckles; this often requires considerable time and labor.

We have also found that there is less liability of the cover or spindle swinging or dipping with this rig when the covers or spindle leave the guides, as it is much more rigid. For lifting the cover you can remove the spindle bars at the end of the beam; this requires the removal of only 6 small bolts and is done in a few seconds. You are now ready to lift the cover. For lifting the spindle put the bars on each end, connect to the beam and shift center link to position where spindle balances. By loosening nuts on the cleat the center cleat can be shifted on the beam



DEVICE FOR LIFTING TURBINE COVERS

without being removed; you have now equilibrium, and are ready without any further adjustment to lift the spindle.

This rig is applicable wherever the stretcher or spreader can be used, and you are always correct in regard to balancing. On starting the lift, if the cover or spindle does not start and lift equally from all points you know the crane or hoist used for the lifting is not in the right position, and must be changed at this time. This rig is best adapted where you have a crane or hoist and I believe that where you have a turbine station installed it is best to make these provisions. We have 2 sizes of turbines in our station, 3 of 1500 and 1 of 750 kw. capacity, and have made 2 rigs, and think we have been well repaid for time, labor and expense.

I have given the dimensions that we used in the drawing, not that any other size material would not do, but this was found around the plant and was used in preference to buying other material. The dimensions are for a 1500-kw. machine.

Those plants that frequently inspect their machines and have cranes for lifting the covers and spindles will find this a useful, convenient and safe device for doing the work. W. J. Maxwell

Starting a Crosshead Pin

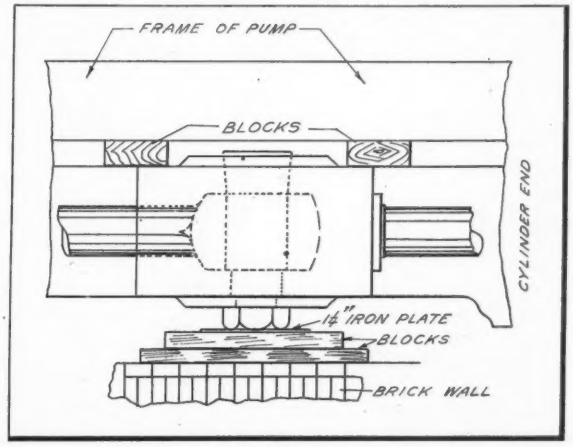
HAVING received much help from your "Letters from Engineers," I would like to submit the following in the hope of helping some one else.

We have two 10½ in. by 12 in. single acting triplex pumps and we wished to remove the crosshead pins, in order to inspect them and also to clean out the oil pockets which had collected considerable grit. We removed two of the pins without much trouble, but as one pump was only 10 in. from the side wall it had to be removed without being hit much of a blow which is so essential in starting a large pin (these being over 3 in. in diameter) or being able to use a screw jack.

We blocked the crosshead in the side, then after getting the nut loose on the pin, blocked up between the wall, using a flat ¼-in. iron plate for a bearing piece to keep the nut from cutting into the block. We then backed off on the nut, which being of large diameter made a good substitute for a jack screw. By keeping the blocking on one side of the nut we were able to strike a light blow with a small copper hammer which started the pin. A. J. Zimmerman.

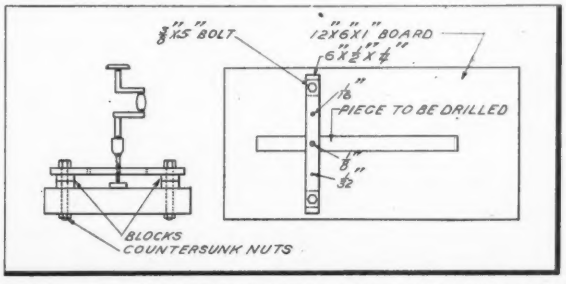
Drilling Small Holes

HEREWITH is shown a twist drill holder for use with a bit stock or bit brace when drilling very small holes. Under such conditions it is difficult to keep the drill steady, and there is likelihood of bending or breaking the drill. I find that with drills over ¼ in. in diameter there is no need of the device shown as the drills are stiff enough to carry without; with ⅛ or 1/16-in. drills this device greatly simplifies the operation.



METHOD OF STARTING CROSSHEAD PIN

Construction is quite clearly indicated in the sketch. The base board should be 6 in. wide, 1 in. thick and as long as necessary to hold the work firm. The iron strap is ¼ in. thick, ½ in. wide, and of length to take in work such as may be in hand.



HOLDER FOR SMALL TWIST DRILLS AND DETAILS OF PARTS

The first step is to bore, in the iron strap, holes the size of the drills which are to be used, and to drill the ends for the ⅜-in. bolts, which are 5 in. long. The heads of the bolts are countersunk in the board in a hole chiseled square so that they cannot turn. Blocking, of wood about 2 by 2 in., should be arranged of thickness so that the steady strap will come about half the length of the drill from the bottom board. The threads on the ends of the bolts should be 3 in. long so that the nuts can be screwed down tight, no matter what thickness of blocking may be in use. It will be found by trial that with this device a hole ⅛, 1/16, or even 1/32 in. diameter may be drilled in a piece of iron with an ordinary bit brace with as great certainty as a ⅜-in. hole without the device here described. M. W. Epperson.

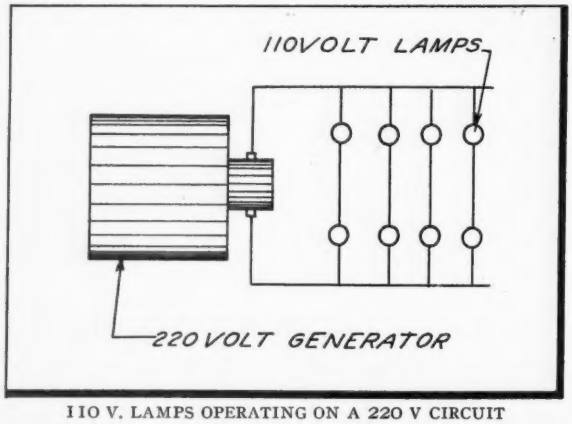
Questions and Answers

To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.

Running a Motor as a Generator

I HAVE a 3-hp. direct current 220 -v. motor which I should like to run as a generator, and light 7, 110 v. lamps. What changes will I have to make in the field connections, and what will be its speed? J. H.

A. A 3-hp. motor, if converted into a generator, would have an approximate capacity of 40 16-candle-power 110-v lamps. It would not be practicable to operate 7 110-v lamps, as it is necessary to connect



110 V. LAMPS OPERATING ON A 220 V CIRCUIT

2 lamps in series across a 220-volt circuit as shown in the accompanying sketch.

If the motor is shunt wound it can be operated as a generator without any change in connections. If it is a compound-wound machine it will be necessary to reverse the connections of the series coils. When running as a generator the speed should be approximately that of the rated speed of the motor.

Injector Problem

KINDLY advise me what kind of an injector to use under the following conditions: We have one feed pump, but if pressure goes below 40 lb. we can feed the boilers from a reservoir, otherwise the pump is depended upon.

Will an injector work with cold water and hot water? The hot water is the returns from the radiators. M. Z.

A. In regard to your questions on the injector, your boiler is probably about 150 hp. and would, therefore, require an injector capable of handling 500 gal. of water an hr. with 100 lb. pressure. This would call for 1-in. injector, that is, an injector having 1-in. pipe connections.

As you want to lift water which is quite hot, it would be best to use the double tube type, or what is sometimes called the "inspirator." You will probably, however, have difficulty in handling this hot water at all with an injector. 120 deg. is about the maximum temperature which can be handled satisfactorily with an injector, and at that temperature it requires rather careful attention and adjustment.

As most of your feed is returns from radiators and, therefore, probably at a temperature of nearly 200 deg., it is not likely that the injector would work satisfactorily.

Miscellaneous Questions

HOW much steam does it take to make one gallon of distilled water?

How much water in a 5½ by 12½ ft. round tank?

The tank is used for the hot water returns and I have a high pressure trap dumping into it. Every time it dumps it makes a loud noise. There is a 1-in. pipe going out of the top and if I plug that the pump doesn't work right. I would like to find some way of stopping the noise.

Please show how to find the cubical contents of a square tank. P. R.

A. One gal. of water weighs 8⅓ lb. It would take 8⅓ lb. of steam to give 1 gal. of distilled water regardless of the boiler pressure.

In a tank 5½ ft. diameter by 12 ft. long there would be approximately 296 cu. ft., 2,221 gal. or 18,520 lb. of water.

The trap evidently discharges into the tank below the surface of the water. Arrange the piping so that the discharge from the trap enters at the top of the tank or at any point above the surface of the water. If this is impossible you can stop the noise only by letting the trap discharge outside of the tank.

Suppose the tank is 6 ft. high, 3 ft. wide and 8 ft. long. The cubical contents would then be 6x3x8 or 144 cu. ft.

Safety Valve Lift

AS large manufacturers of spring loaded pop safety valves we have read with much interest your article relating to pop safety valves on page 95.

We note that you state that the lift of a well designed safety valve should be about 1/33 of the diameter of its inlet, which makes the actual lift when in active operation much less on a small valve than on a large valve, and we presume you got this erroneous idea from the rules frequently used, which are based on a theory, and which are not correct, as we have found in many years of practice and in manufacturing pop safety valves that valves of a given design, no matter what size, when properly made, will all have the same lift, and we have found in making tests of various makes of safety valves of different designs, where they were all built for the same working pressure and of the same size, that they had a variation in actual lift of more than 400 per cent.

We are simply giving you these facts, as we feel sure that you would not want to publish anything that is erroneous in your paper. J. E. Lonergan Co.

M. A. Hudson, Vice-President.

Laundry Ventilation

IN the wash kitchen of a steam laundry we are troubled with considerable moisture on cold days. The entrance is protected by double doors, and when opened the vapor from the steam mangles becomes so thick that operators at the machines cannot be distinguished.

Would it be advisable to install an exhaust fan or put in ventilators? There are no ventilators in the roof and the moisture that arises from the first floor to the second through the stairway and elevator shaft condenses on the under side of the stairs.

There is a 36-in. exhaust fan on the second floor. Kindly explain how I can overcome the difficulty. J. Y.

A. Should advise putting a hood over the mangle and connect outlet of the hood to an exhaust fan. The fan on the 2nd floor should be slowed down some if possible, or else the elevator shaft and stairway should be closed by doors, because the 36-in. fan upstairs will draw the air and vapor from the 1st floor to the 2nd unless the exhaust fan on the mangle is more powerful than the other. I do not think ventilators would be sufficient in this case.

A system of pressure in the room, that is, air blown into the room through a small heater to warm the air slightly would be the ideal solution of that problem, because if that was done, the opening of doors or windows would not let in much cold air, as there would be a slight pressure in the room instead of a partial vacuum as in the case where an exhaust fan is used, also ventilators could be used to let out the foul air and steam. But, if this system is used, the elevator shaft and stairway would need to be closed.

Eccentric that Slipped

HOW would you reset an eccentric which had slipped, without removing the steam chest cover? G. A. W.

A. Resetting an eccentric which has slipped, without taking off the steam chest cover, is purely a matter of guess work and the guess of the man who has seen the engine running is better than that of the man who has not, because he will probably have some idea of about the position of the eccentric with relation to the crank and flywheel.

With an ordinary D valve engine having the valve direct driven by the eccentric, the eccentric would set some 120 deg. ahead of the crank. If there is a reversing rocker arm between the eccentric and the valve, the eccentric would set about 60 deg. behind the crank. If the valve takes steam on the inside instead of the outside, the positions would be just reversed.

Engine Cards

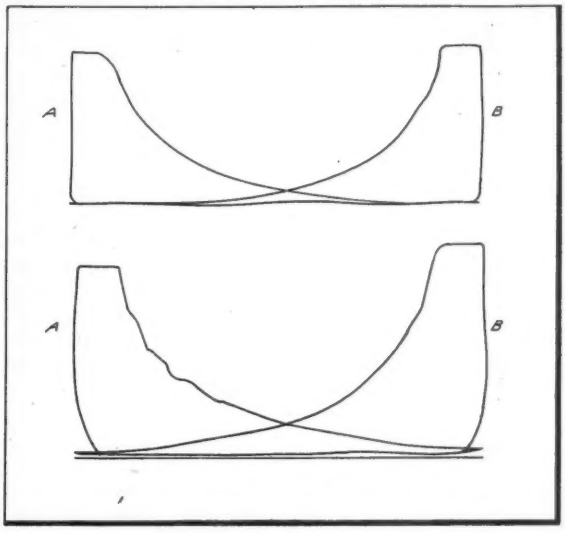
TWO cards shown herewith were taken from our engine, one noncondensing and the other condensing. I wish you would tell me what you think of them and what you would suggest doing. I have my own opinion which does not coincide with the opinion of the superintendent and engineer. E. M.

A. On the noncondensing card which you have submitted we would suggest that you advance the eccentric a little so as to make all the events a little earlier. The compression is hardly what we would call enough to secure a smooth running engine under all conditions, and from what we can see of the release, it also is late.

On the end of the card which we have designated "A," the admission line leans away from the vertical, which shows tardy action. This is also borne out by the fact that this end of the card scales but about 86 to 88 lb., while the end "B" scales about 98 lb. which is only about 2 lb. below boiler pressure.

We take it that these are not representative service cards but are friction cards, as the cutoff is but 11 per cent and the steam pressure is but 100 lb. at the boiler, while you say that ordinarily 140 lb. is carried.

It will be a profitable investment to get a spring for your indicator so you can take cards at 140 lb. pressure. An 80 spring will answer very nicely. Then watch your load and take cards at various loads until you can strike "a happy medium," that is, a point where the cutoff will average between 20 and 25 per cent, then as the load falls off (if it does), permit the



CARDS FOR CRITICISM

steam to drop also, so that the cutoff will be at the most economical point.

Fault with your card marked "condensing," is not in the engine but in the manner of applying the indicator. The indicator piston is screwed in so far that the pencil is not allowed to make a full card.

Adjust the piston so that the card will be traced very close to the center of the paper both ways. Even the noncondensing card could be a half inch higher on the paper.

The indicator is just as important an appliance in the engine room as the oil can and the lubricator, and is just as necessary to economy as a flue scraper or a clean boiler.

Capacity of Refrigerating Machine

HOW can I calculate the amount of refrigerating work being done by a 30-ton absorption refrigerating machine while the machine is running. C. G.

A. In regard to the amount of refrigerating work done by your absorption machine, you can calculate this either from the amount of brine circulated or from the ammonia gas handled. If you are using the brine system a capacity of ½ cu. ft. in the brine pump per minute, with a difference of 6 deg. F. between outgoing and returning brine, would give you a ton of refrigerating capacity in 24 hr. or about ½ ton of ice-making capacity.

Figuring on the ammonia gas to be handled, about 510 lb. of ammonia must be expanded from liquid to gas to produce one ton of refrigeration. The weak liquor will absorb about 25 per cent its weight in ammonia gas, so that by figuring the amount of weak

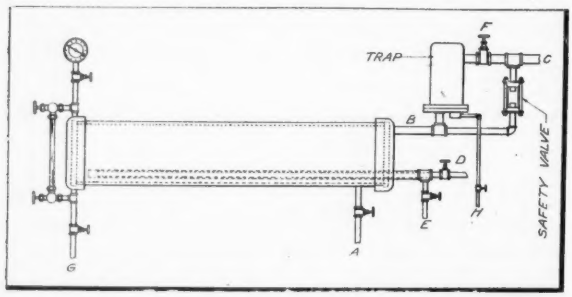
liquor handled by the pump and taking ¼ of that as the amount of ammonia circulated, dividing that weight of ammonia circulated in 24 hr. by 510, you can get quite closely the refrigerating capacity of your plant as it is operating. The weak liquor handled can be computed by figuring the pump displacement from the diameter of the pump piston and the number of single strokes in 24 hr., and the length of stroke, and taking about 80 per cent of this, allowing 20 per cent for slip and leakage.

Removing Water From Ammonia System

PLEASE send us directions for taking water out of our ammonia system which seems to have accumulated there. H. W.

A. In regard to the matter of purifying your ammonia of water, the only way this can be accomplished is by redistillation. As you are aware, ammonia is soluble in water, about 800 volumes of ammonia gas to one volume of water. The only way that this can be gotten out is by keeping the liquid at such a temperature that the ammonia evaporates and passes off, the water being left in the distilling tank.

This is usually best done by the use of a steam heating coil, shown in the figure. Liquid ammonia with the water mixed with it is let into the distiller from the liquid receiver or direct from the condenser through the inlet A. The valve in this inlet should be left open until the glass gage shows that the receiver is slightly more than half full. The inlet valve is then closed and the suction from the compressor will relieve the pressure, allowing the ammonia to expand in a gaseous form. Ammonia vapor passes out through pipe B into the liquid trap and then through pipe C to the compressor suction line.



APPARATUS FOR PURIFYING WATER OF AMMONIA

To accelerate the evaporation of the ammonia a steam pipe is provided, steam entering through the pipe D, which is enclosed in a larger pipe, and the condensed steam being drawn out through the pipe E. The temperature of the liquid ammonia should not be raised above 70 deg. F. and that means that the pressure on the gage should not go above 95 lb. This temperature is high enough to make evaporation of ammonia rapid and at the same time low enough to prevent vaporizing any oil or water.

By watching the pressure gage it can be seen when the operation is complete and when all the liquid which will evaporate has been vaporized. The outlet valve F on the suction line of the compressor should be left open until the pressure is reduced to that existing in the suction line to the compressor, as shown by the low-pressure gage in the engine room. Then close valve F and draw off the remaining liquid through the drain pipe G, which should be at the lowest point of the purifier. Any impurities accumulating in the liquid trap are drained off through the pipe H and a safety valve may be provided as indicated, to prevent any danger of accident.

Of course, the apparatus need not be made up in just the form shown, but is best arranged with the drains as indicated, and should have an evaporating surface of about 6 sq. ft. By passing all of the ammonia in the plant through this purifier, water and other impurities will be taken out.

Changing Generator Voltage

SHOULD like to know if a 250 volt generator with 120 amperes capacity can be changed to 110 volts. F. T.

A. In regard to your inquiry, it would be practically impossible to reduce the voltage of a machine built for 250 volts to 110 except by rewinding. The only way it could be done would be by cutting down the speed and cutting down the field current and you would get then to a condition where the action of the machine would be very unstable and a slight change in the load would make a lot of difference in the voltage. Also, if you did cut down to 110, you could still carry only 120 amperes.

The proposition is not desirable. You should have a new armature if you wish to change to 110 volts.

Transfer of Water at High Temperature

WILL an inspirator transfer water at a temperature of 200 deg. F. from a tank located above the inspirator (the water flowing down to the inspirator by gravity) to a tank still higher than the supply tank? If not, what would be the best way of transferring water at this temperature from one tank to another tank higher up? A. C. G.

A. The action of the injector, in such a case, depends only on the kinetic energies of the steam and flowing water, and not on vacuum, therefore it will work provided the water is sufficient to condense the steam. At 200 deg. it has not much condensing ability, and it is doubtful if an ordinary injector would be suitable.

Almost any pump, with a plunger packed with hydraulic packing, would answer well for the purpose.

Babbitting Brasses

IF a crank pin brass or brasses have to be babbitted, how would you know how much to put in them?

How do you find correct position of eccentric with piston or crank on dead center? J. F. McI.

A. This is best told by rotating the newly babbitted brass on the pin or an equally sized mandrel, the pin or mandrel first being coated with chalk or some other marking substance. The high spots will in this way be shown which may then be scraped down till the entire bearing touches the pin.

The eccentric should be ahead of the crank pin, or piston, by an amount equal to the lap plus the lead.

In setting the valve, first see that the valve has equal travel both sides of center. This is done by loosening the eccentric and adjusting the length of the rod.

Now place piston on dead center head end. Throw the eccentric around the shaft until the valve is on the edge of the head end port about to admit steam. Then send it ahead a little further until the valve stands open for the desired amount of lead and tighten the set screw. The eccentric is then properly set.

Problems for Discussion

What Would You Do Under These Conditions?

Peculiar Action of Ceiling Fans

NOT long ago we had a peculiar experience with an installation of ceiling fans. In the accompanying sketch A, B and C represent the fans which had not been in operation for 3 months. Suddenly fan A burned out, then when it was revolved fans B and C also revolved but in a reverse direction to that of A.

Single-pole switch was not closed but fans B and C

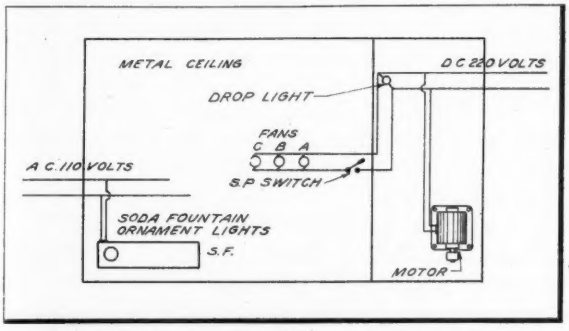


DIAGRAM OF CONNECTIONS OF FAN INSTALLATION

continued in operation until the circuit opposite to the switch was cut.

Tests have failed to reveal a ground on either side of the circuit. Explanations of this phenomena will be gladly received from readers of Practical Engineer.

J. W. Stevens.

Commutator Sparking

IN the mill where I am employed is a 150-kw. 110-volt 500 r.p.m. compound-wound generator with 8 poles which has been in operation since March, 1901. It is a double commutator machine, the voltage at one end being 66 and at the other 44. For the past year it has given much trouble at the 66 volt, and to some extent, on the 44 volt side; the trouble starts with a slight lift of the brushes which causes sparking, and which increases until it resembles the report of a rapid fire gun. On examining the commutator, I find 8 burned places, equally spaced, around the commutator and each place consisting of 3 or 4 blackened bars, with the mica insulation burned away, giving the indication of an open circuit. Examination and testing of the armature does not disclose any break in the winding. Truing up with a commutator truing device does away with all trouble for 4 or 5 weeks, when the same course of events is repeated. Can any one give any explanation of this trouble and tell of a remedy?

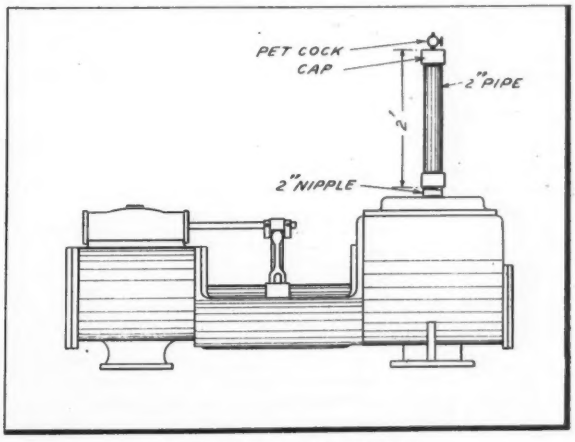
G. E. G.

Answers to Problems

IN the March 1st issue on page 271, H. J. asks how to use No. 7 boiler for supplying steam to the high speed engines. He does not state whether or not the boiler is internally fired. It is assumed, as most Lancashire boilers are, to be internally fired.

As the fuel burned is only smudge from the washing plant, with a calorific value of 6000 B.t.u., it seems to me that if he could get his employer to use a stoker of some kind he could get a much larger grate surface; also the grade of fuel he is using could be handled better by a mechanical stoker than when hand fired. There are several mechanical ways of improving the draft. An increase of grate surface or an increase of draft would mean a large improvement to the supposed existing conditions.

2. On page 271 of the same issue, there appears a problem under the heading "Pounding of Check Valves." I would recommend that an air chamber be placed on top of the pump as shown in sketch. If the air chamber improves the operating conditions of the pump, it could then be removed, the head bored and tapped to receive a larger air chamber, made the same way as the first chamber only using larger pipe and fittings. If it does not improve it,



AIR CHAMBER FOR PUMPS

the pipe fittings can always be used around a plant, so that there would be nothing lost and the experiment would take but a few minutes after the chamber was made.

On page 271 there appears another problem under the heading, "Expansion Bends in Steam Pipes." Assuming the pipe to be thoroughly anchored so that each expansion bend receives its equal share of expansion and contraction, it seems to me that there was not enough of a sweep to the bend, making all the expansion and contraction take place in one part. It is hard, of course, to say what was the real cause of the trouble.

Anchors may have become loose, allowing all the expansion and contraction to take place in one bend, which, as stated, is about 11 in., causing too much strain. If I were repairing the break I would make sure that the anchors were secure and have the bends made with a larger sweep and preferably made of copper, as copper will stand more bending before breaking.

John Mitchell.

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CONTENTS

Gas Engine For Ice Making. Illustrated....395
Fan vs. Chimney....397
Uniform Boiler Specifications....398
Purchasing a Boiler. By Hubert E. Collins....402
Details of Power Plant Design. By Charles L. Hubbard. Illustrated....404
A Gas Engine Isolated Plant. Illustrated....406
Gas Engine Desirabilities. By John Meyerott. Illustrated..407
Piston Rings. Illustrated....408
Sargent Gas Engine Driven Air Compressor. Illustrated....409
First Annual National Gas Engine Show....410
Conveying and Elevating Machinery. By Reginald Trautschold. Illustrated....411
Induction Motor Troubles. By Carl D. Knight. Illustrated..414
Storage Battery Practice. Illustrated....416
Electric Power for Underground Winding and Hauling Engines. Illustrated....417
Emergency Lighting and Plant. By F. C. Barton. Illustrated.418
Lozier Five-Ton Truck. Illustrated....420
Power Costs....422
On Duty....423
Water Power for Pittsburgh....423
Letters from Engineers: Clean Breechings. Water in Receiver. Substitute For Pipe Vise. Alarm Water Column Piping. Engine Adjustment and Tests. Characteristic But Perplexing Diagrams. Proper Examinations. Hump Caused Pound. Is Smoke a Sign of a Hot Fire? Daily Meter Readings. Bursting Pressure of Boiler. Spring for Dashpot Rod. Cards from Automatic Engines. Certain Guides. Automatic Hot Well Pump. Illustrated.424
A Temporary Slide Rule. By Ernest J. Beattie. Illustrated.429
Designing Oil Engine Parts....429
Successful Kinks: A Lathe Job. Device for Lifting Turbine Covers. Starting a Crosshead Pin. Drilling Small Holes. Illustrated....430
Questions and Answers: Running a Motor as a Generator. Injector Problem. Miscellaneous Questions. Safety Valve Lift. Laundry Ventilation. Eccentric that Slipped. Engine Cards. Capacity of Refrigerating Machine. Removing Water from Ammonia System. Changing Generator Voltage. Transfer of Water at High Temperature. Babbitting Brasses. Illustrated....432
Power Plant Problems. Peculiar Action of Ceiling Fans. Commutator Sparking. Answers to Problems. Illustrated....435
Editorial: Are We Crazy? Operating Costs....436
An Isolated Triumph. By Joshua O'Leary....437
Metering Coal in Power Plants. By O. D. Harvard. Illustrated....438
Golden-Anderson Automatic Float Valve. Illustrated....440
Kelly Rocking and Dumping Grate. Illustrated....440
Balanced Draft System of Furnace Regulation. Illustrated..441
A Refillable Cartridge Fuse. Illustrated....442
News Notes....442
Catalog Notes....442
Trade Notes....444

ARE WE CRAZY?

Our national habit of extravagence has been and is being frequently commented on by writers in magazines and newspapers. We cry out at the increasing cost of living, tax ourselves, and spend large sums for luxurious accommodations in government and business buildings, and try to get as costly clothing, furniture and automobiles as our neighbors whose incomes are larger than ours. We despise small savings and wonder why we do not accumulate more surplus. We dread the exhaustion of our timber and mineral resources, but take no serious steps to avoid waste. We build and equip for manufacturing largely, and then proceed to burn up each year half that we have built.

Is it any wonder that industrial and living conditions are showing these burdens?

Efforts to conserve the resources with which Providence has favored our country are having some effect, but meantime, we look as fatalists on the immense fire destruction—and go our careless way. If a bonfire should be started and every man, woman and child in the community should file by it and throw upon it $3 in bills, would it arouse comment or start a protest against such wastefulness? Yet that is a yearly performance in this country. Three dollars per capita fire loss—and in 6 European cities only 33 cents. All due to carelessness and lack of adequate fire protection.

Fire insurance doesn't stop the loss; it only distributes it, so that you help bear the burden of your neighbor's misfortune. Even if he has no fire, the cost of insurance is added to the cost of manufacturing and of distributing, thus increasing the price of what you buy; clothing, bread, building material, your daily paper—all cost more because of the necessary insurance. And the burden can be removed only when every individual has learned to cooperate to reduce the waste by fire. Carelessness with matches, accumulation of quick burning rubbish, building construction that permits of rapid spread of fire, lack of means to put out a small fire when it starts, have been the cause of most of our big fires, as well as little ones.

Individual responsibility must be the remedy. Each man must see to it that in the home, the plant, the office these things are guarded against by those who work with him, as well as by himself. This will go a long way to reduce the loss which is now $30,000 an hour for every hour of the 24, every day of the 365 in a year. If every man would start today, and the loss was reduced only one half, the country would be richer tomorrow by $360,000. It is time we got sensible in this matter, and prevented our wastes to reduce our cost of living. Then it will be time to look over expenses and see what we are spending foolishly that might better be spent for things really worth while.

SOME MEN need criticism and others praise to bring out their best work; and do not forget that if the prescription is switched, it is often a poisonous dose in either case.—Mahin Messenger.

OPERATING COSTS

How much does it cost you to operate your plant? This is a question often asked, but in comparatively few cases can it be answered in detail.

Power plant economics is a subject that receives too little consideration from the "big ones" up in the front office. So long as the wheels revolve and repair bills are not so excessive as to attract especial attention, this important feature of a business is too often neglected. The answer is often given, "Oh yes, by looking through our bill files we can find out how much coal we used and there is Jim, the engineer; his salary is so much, and Frank, the fireman, gets so much, that's close enough for practical purposes."

No thought is given to interest on investment, depreciation, value of space occupied by the plant, the various sundry repair bills of a minor nature and many other details which enter into actual operating costs as much as salaries and coal.

Naturally the boss is not interesting himself in details, such as log sheets, indicator cards, gage records, and the like that are necessary tor the engineer to keep intelligent track of the relation between output and operating expenses. It is, then, up to the engineer to assume the initiative and bring the importance of accurate records to his employer's notice? Sometimes when this is done the engineer will meet with a rebuff, but what of it? "Keep a goin'," and when the owner finds that, for example, a certain pump has cost more for repairs in a year than a new one would cost, a new pump will be installed. This applies equally well to any or all of the auxiliary apparatus in and about the plant.

Are you getting as much evaporation per pound of coal in your boilers as you should? If not, why not?

There is never a cause without a reason, and some extra time and intelligent observation will often materially reduce some particular item of plant charges.

When reductions in operating expenses, brought about by the remedying of some "leak" in the daily routine, have been brought to the attention of the man higher up, the engineer will rise in his estimation and he will gain some individuality and not be considered one of the proverbial spokes in the wheel of everyday routine.

The importance of economics in the power plant should be recognized and it would seem that it is up to the engineer in every plant to start something. Suggestions will be gladly offered and help extended wherever possible.

THE BEST WAY to thaw out a frozen pipe is to take some old discarded clothes, waste, old carpet, or anything of that kind, and lay it on the pipe to be thawed out. Get hot water and pour on it. The cloth will hold the heat to the pipe and thaw it out in 5 minutes.

AN ISOLATED TRIUMPH

Victory for the Right of an Individual to Supply His Own Lighting Current

BY JOSHUA O'LEARY

A PROTRACTED controversy of interest to engineers, as well as to power plant owners and the general public, has recently been brought to a close at Worcester, Mass. A. S. Lowell, one of Worcester's most progressive and successful business men, is the owner of a large, modern building which he erected for commercial and manufacturing purposes on Foster St. in the business center of the city.

In the basement of this building he installed a well equipped plant for generating heat, power and electric lights for the use of the occupants; and this plant, though modest in size and scope, has been productive of more discussion, and has aroused more general interest than has the largest plant ever operated in Worcester.

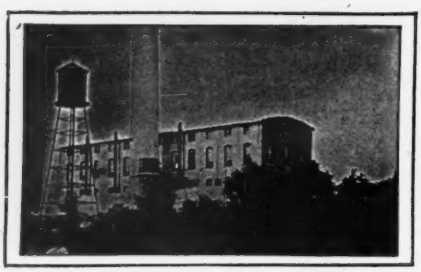
Some 2 years ago Mr. Lowell, having decided to move his business to Main St., leased the building on the corner of Main and Foster St. across the street, and a few rods distant from his own building. In the course of the changes made necessary by this move Mr. Lowell, with permission from the Board of Aldermen, constructed a conduit for electric wires underneath Foster St. so that he might obtain electric light for his new place from his own power plant across the way. To his surprise and that of the citizens generally, this obviously proper and rightful procedure encountered vigorous opposition from the Worcester Electric Light Co., which, for electric light transmission, claimed exclusive rights in the street, extending apparently, from the surface to the center of the earth.

In pursuance of its purpose to make good its claim to exclusive use of the streets the electric light company appealed to the State Gas and Electric Light Commissioners and obtained from them an order forbidding Mr. Lowell to run his wires under the street. After considerable discussion the matter was again brought before the Board of Aldermen and again formal permission was given Mr. Lowell to carry out his plans. But again the interference of the state officials was invoked by the Worcester Electric Light Co. and again Mr. Lowell was enjoined by them from supplying himself with light.

This conflict of authority between the city of Worcester acting through its highest municipal body, and the State Commissioners at Boston, introduced into the controversy a question of still larger public concern, namely, the rights of the State Commissioners to exercise paramount authority and control over streets constructed and maintained by a city.

For over 2 years the contest was waged fiercely not only before the state and city tribunals but also in the public press. It has also extended to the political arena and engaged the attention of party conventions. The result has been that the president of the electric light company recently announced the formal abandonment of its opposition; and now Mr. Lowell is enjoying in his business the economy and advantages of his isolated plant, untrammeled by interference from the central station or the orders of the State Commission.

The outcome of this strenuous and extended controversy, which was conducted by Mr. Lowell with signal ability, is a victory of far reaching importance, not only to himself and to owners of power plants who may be similarly placed, but also to the people at large, whose right to exercise entire control over their municipal thoroughfares he has so effectively upheld and so completely vindicated.



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

METERING COAL IN POWER PLANTS

Apparatus and Forms for Keeping a Complete Record of Coal Used with Minimum of Labor

By O. D. Havard

TO the engineer who is serious in his efforts to operate economically, there is nothing that gives him so much assistance in accomplishing results as complete plant records. To be of the greatest value, these records should be continuous. With reliable continuous records at hand, the alert engineer can be constantly on the heels of his operation; the effect of changes of any nature can be detected immediately and, if found to be detrimental to economy, he knows just how much, and therefore how quickly to apply the remedy.

The most vital part of all power plant records from

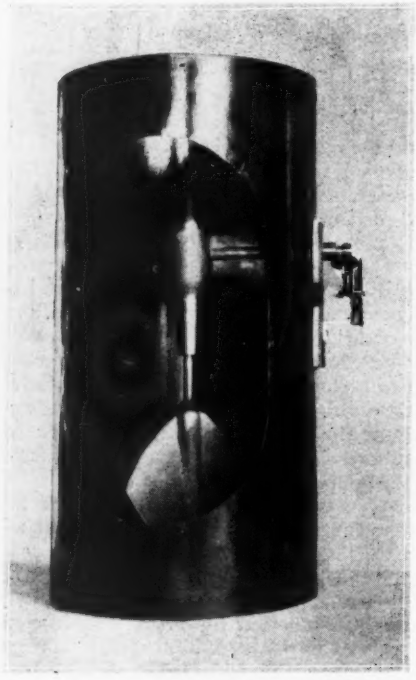


FIG. 1. HAVARD HARD COAL METER WITH ONE SIDE OF PIPE CUT AWAY TO SHOW THE VANE

the standpoint of economy, is that which points back to the coal pile. The more direct this information can be obtained, the more valuable it is, hence a method of direct metering is of great interest.

As an example of how dependable a device the coal meter is, the records for one year of 14 meters in one plant showed a maximum error of 6 per cent for a month's supply and an average of 0.84 of one per cent on monthly records as given by the inventory.

In the monthly variation it is obvious that the inventory is as liable to error as meters. The variation for a year is less than 1 per cent which could hardly be surpassed by any method of measurement. These meters have been in constant service for almost 3 years.

From information furnished by Figs. 2 and 3, it will be seen with what facility the whole operation can be checked. As the meters are read at the end of each 8-hr shift, it can be ascertained at once how much coal the shift handled; or any particular fireman or boiler; how much coal required to clean a fire or to carry a banked fire; the evaporation of water per pound of coal, if water is measured; how many pounds of coal per kw.-hr. at switchboard, etc. This last item serves as a valuable check on the over-all efficiency as it shows the comparative economy of different methods

Form 10—2m-2-09

O—Banked
I—Cleaned
X—Off Line

Power Co.

Fireman's Record. Date Mar 30 19[illegible]

	1	2	3	4	5	6	7	WATER	FIREMAN'S CREW
12	X	X	/	/			X		1 Joe Donnell
1	X	X			/	/	X		2 Witkoski
2	X	X			O	O	X		3
3	X	X			O	O	X		4 #51
4	X	X			O	O	X		ASH 10 BUGGIES
5	X	X				O	X		
6	X	X				O	X		
7	X	X					X		
8	X	X	/				X		FIREMAN'S CREW
9	X	X	O	/			X		1 Burns
10	X	X		O			X		2 Bates
11	X	X			/		X		3
12	X	X			O	/	X		4 #17
1	X	X				O	X		ASH 10 BUGGIES
2	X	X				O	X		
3	X	X				O	X		
4	X	X	/				X		FIREMAN'S CREW
5	X	X		/			X		1 Waldman
6	X	X			/		X		2 Langan
7	X	X				/	X		3
8	X	X					X		4 #18
9	X	X					X		ASH 12 BUGGIES
10	X	X					X		
11	X	X					X		

REMARKS.

FIG. 2. FIREMAN'S RECORD OF PLANT OPERATIONS

of operating. As an example, in one plant it was found that a certain desirable operation was 24 per cent less economical than another possible means of accomplishing the same thing.

The application of this device to steam sizes of hard coal is simple and only requires the meeting of 2 primary underlying conditions: First the pipe must be completely filled with coal at point of meter; and

second, the cross section of coal must move uniformly. If coal should fall on the meter in a shower, the revolution of the vane will bear no relation to amount of coal passing. When the cross section does not move uniformly, there will be a shearing across the vane which, unless always the same, will affect the accuracy of the meter.

The meter should always be placed as far as possible above any influence tending to disturb the stream, such as: outlet of pipe, a branch in pipe, a sharp turn or valve that may be left partly open. It is also advisable to have pipes as nearly vertical as possible. We do not mean that Fig. 4 represents the only right or the only wrong way, but is an illustration of how it is possible to modify the movement of coal to make it favorable for metering.

In metering soft coal, the requirements are more exacting on account of the varying size of lumps and the fact that it does not flow so freely as hard coal. But, after considerable experimenting, a meter has been developed which has given perfect satisfaction under proper conditions. It is essential that the pipe in which the meter is placed be vertical or nearly so, and that it be of ample size to prevent clogging at the meter.

When the hard coal meter, Fig. 1, was found to be satisfactory in hard coal, attempts were made to apply it to soft coal without modification. These efforts met with failure, and it was not for some time understood why. An experiment was made with a vane much reduced in diameter and increased in length,

Coal Meters

Meter	Rev. Rdg	7 AM.		Diff	3 PM.		Diff	11 PM.		Diff
1										
2										
3										
4										
5	5398	14	5400	10	1-16	5405	04	4-14	5408	16	3-12
6	968	02	971	12	3-10	976	18	5-06	981	00	4-02
7	7770	16	7771	06	-10	7774	06	3-00	7777	18	3-12
8	6823	04	6826	02	2-18	6830	12	4-10	6836	08	5-16
9	1266	02	1267	18	1-16	1271	04	3-06	1274	14	3-10
10	6398	14	6400	16	2-02	6402	14	1-18	6406	18	4-04
11	708	06	709	06	1-00	712	18	3-12	716	18	4-00
12	5247	12	5249	00	1-08	5250	06	1-06	5251	16	1-10
13											
14											
				15-00			27-12			30-06

Tons - Cwt
15 — 00
27 — 12
30 — 06
72 — 18

H_2O - 998700 = 6.84 lb.
Coal - 145800
Coal - 145800 = 4.07 lb.
KW - 35830

FIG. 3. LOG OF METER READINGS AND CALCULATION OF RESULTS

having a shield over the top to keep lumps from striking the cutting edge, the theory being that when a lump struck any point of this cutting edge, the vane would have to stop until the lump had descended to the curvature of the vane. The erratic movement of the unprotected vane indicated this and the experiment proved the assumption to be correct. With the shield, the soft coal meter moves with perfect smoothness.

For a time the vanes of soft coal meters were made 4 in. in diameter and this required a shield of such size that it was necessary to enlarge the pipe to receive it. After some observations on the turning force of coal on a spiral vane, it was decided to reduce the diameter to 2 in. As shown in Fig. 5, the vane is sheltered by the meter body and the total obstruction in center of pipe is a pointed cylinder, 2¼ in. diameter.

There is the decided advantage with this means of measuring coal that no correction need be made for moisture as it can be calibrated for dry coal at the outset and will continue to be read dry coal.

No effort is made when sending meters out to provide them with gears that will make them read correctly. Conditions vary so widely that it is not practical to do this. Instead, the meter is provided with a gear of a known number of teeth. When installed, the meter is calibrated and a constant found under actual operating conditions. This constant is sent to the manufacturer and a new gear is sent out with the right number of teeth to make the meter read correctly.

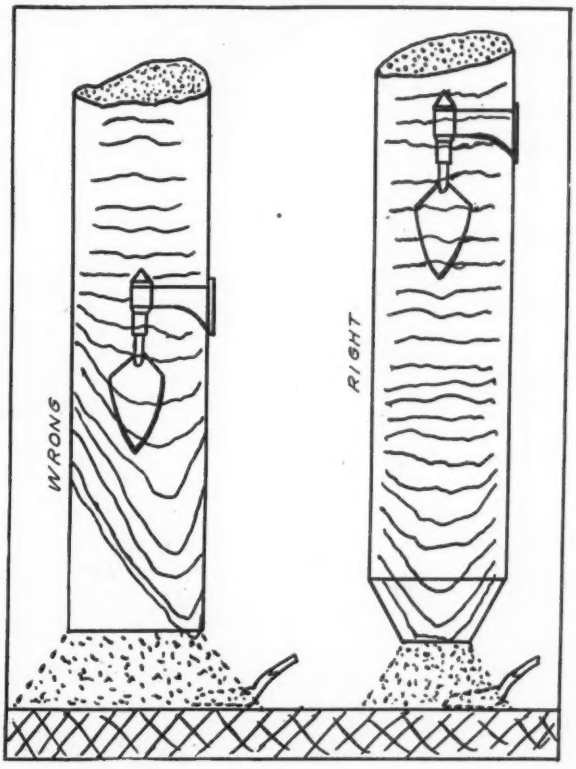


FIG. 4. WRONG AND RIGHT METHODS OF INSTALLING THE METER

It is not at all difficult to calibrate these meters to come within 2 per cent of scale weight when observations are all reduced to dry coal in making comparisons.

This device will not solve all measuring problems. Its successful operation depends upon so controlling the stream inside the pipe as to make it uniform at all times. The meter vane can not help but travel with the coal and if the movement of coal is always the same, the meter will be consistent and reliable. If the meter is erratic, it can be concluded at once that for some cause the flow in the pipe is erratic. When the cause is studied out and corrected, the meter will become consistent. For this reason, it is usually more satisfactory to install meters in new work when the designing engineers can be guided by the manufac-

turers' experience in laying out the piping to the best advantage.

With the present price of coal, the time is certainly

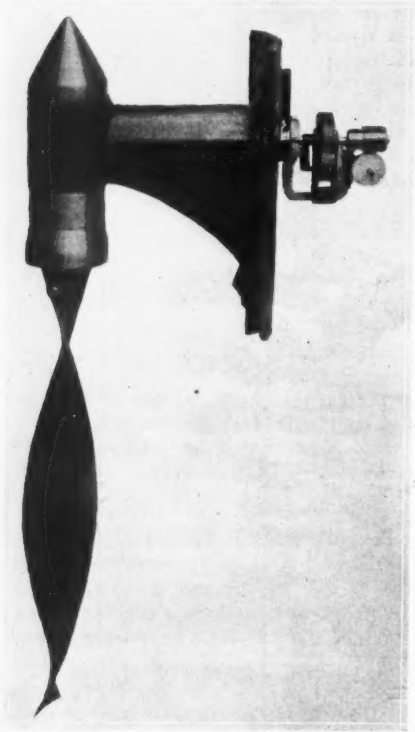


FIG. 5. WORKING PARTS OF SOFT COAL METER

at hand when no plant of even moderate size should be without some means of checking its coal consumption daily. For this purpose, the coal meter will serve a need in boiler room equipment such as the water meter meets today.

GOLDEN - ANDERSON AUTOMATIC FLOAT VALVE

FOR automatic control of the supply of water to heaters, tanks, vats, etc., where a balanced valve not affected by the pressure is required, the new Golden-Anderson Automatic float valve contains a number of notable features.

By changing the plug from one inlet opening to the other the valve may be used either as a globe or angle valve. The float lever swivels from the center of the valve and can be placed at any angle in the tank by loosening the lock screw at A.

As shown in the illustrations the valve is closed. When the lever E is operated by a float, rod, or other connection the valve is opened allowing the water, or other fluid, to enter the valve through the inlet KK and flow to the tank under the disk B. At the same time the water flows through the port L and maintains a balance. When the level in the tank rises to the point of contact with the float the valve closes and the balance of the valve is then sufficiently maintained by the pressure above B and underneath C.

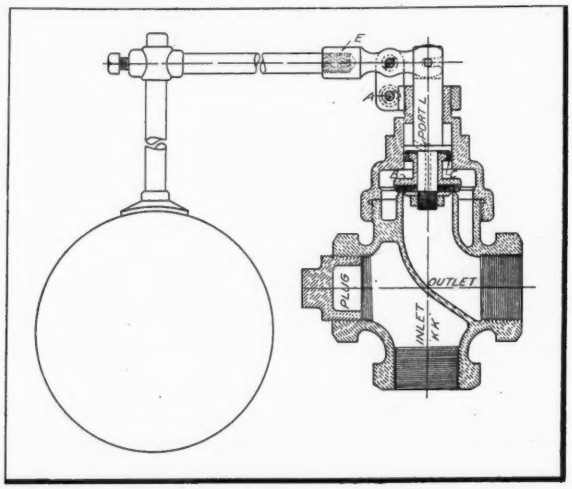
The valve is made of bronze but has no metal to metal seats. The valve is cushioned in opening and closing and direct connection of the inner valve to the float assures positive control.

The Golden-Anderson Valve Specialty Co. is the manufacturer of this new valve.

KELLY ROCKING AND DUMPING GRATE

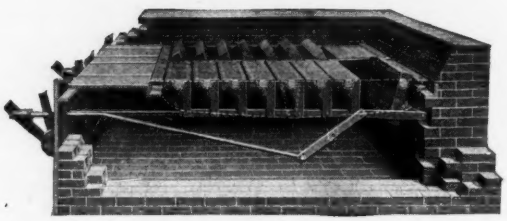
AN improved feature in a rocking and dumping grate is a large rear dump grate, which is operated independently from the main grate surface. By means of this double capacity dump grate the largest clinker formations can be quickly and easily disposed of at the rear of the furnace where combustion terminates.

Residue of combustion must be disposed of after the fuel has performed its heat producing function and 2 ways only are available, namely, to dump into the ash pit or clean out through the fire doors. In modern furnace practice, the dumping process is considered



GOLDEN-ANDERSON AUTOMATIC FLOAT VALVE FOR ANGLE CONNECTION

the right method. There is a great loss in furance efficiency by the forward cleaning of the fires, because it disturbs combustion, and with the opening of the fire doors, the heat producing function of the furnace is destroyed, and the loss represents both fuel and labor in getting the combustion areas of the furnace back to a normal active state again.



KELLY ROCKING AND DUMPING GRATE

By referring to the illustration it can be seen how convenient and easy it is to clean these grates, especially the rear portion which ordinarily receives the least attention, because it is out of reach of the fireman, but with this wide dump grate, it is really the easiest portion of the grate surface to clean; and can be done without extra exertion or exposure to heat and dirt. A combination of this rocking and dumping feature entitles this grate to recognition as a modern device for coal burning furnaces; and while it is a hand firing device it embodies 3 prominent features of a mechanically fed furnace.

First. The agitation and breaking up of the fuel bed by the rocking movement. Second. The tendency of the rocking motion to shift the fuel to the rear. Third. The large dumping grate at the rear of the furnace which enables the operator to dump the accumulation of clinker and ash.

This grate is the product of the Kelly Foundry of Goshen, Ind. It is made to fit any size furnace and with air space best adapted to the kind of fuel used. It is self contained and does not require any alterations in the ordinary furnace to install.

BALANCED DRAFT SYSTEM OF FURNACE REGULATION

FUNDAMENTAL principle of balanced draft control is maintaining in the furnace chamber, at the the furnace door, any predetermined atmospheric pressure, or what is commercially known as "Balanced Draft." A higher percentage of CO_2, and a higher and more even temperature are maintained when operating boiler furnaces under balanced draft. The flue gases are also lower. Charts A and B, Fig. 1, show the results of an actual demonstration of how the theory of balanced draft works out in every day practice .

One of the advantages in operating with the balanced draft system of furnace control, other than those obtained in economy and efficiency, is reduction in the cost of upkeep of the boilers and boiler settings. This is due to the fact that no cold air is drawn into the furnace during the time of firing, thereby preventing expansion and contraction due to this cause. When operating with balanced draft system of control the stack capacity can be increased at least 50 per cent.

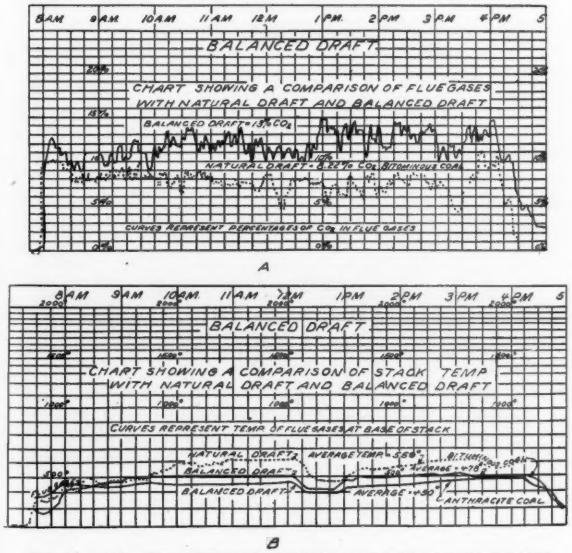

BALANCED DRAFT
CHART SHOWING A COMPARISON OF FLUE GASES WITH NATURAL DRAFT AND BALANCED DRAFT
BALANCED DRAFT-13% CO2
NATURAL DRAFT-8.2% CO2 BITUMINOUS COAL
CURVES REPRESENT PERCENTAGES OF CO2 IN FLUE GASES
A
BALANCED DRAFT
CHART SHOWING A COMPARISON OF STACK TEMP WITH NATURAL DRAFT AND BALANCED DRAFT
CURVES REPRESENT TEMP. OF FLUE GASES AT BASE OF STACK
NATURAL DRAFT
BALANCED DRAFT
AVERAGE TEMP. 556°
AVERAGE = 478°
AVERAGE = 450°
ANTHRACITE COAL
B

FIG. I. CHARTS SHOWING EFFECT OF BALANCED DRAFT CONTROL

Figure 2 shows a typical application of the balanced draft system of furnace regulation on a horizontal water tube boiler.

Description of its Operation

INDIVIDUALIZATION of the boiler units is obtained by this regulation, as each boiler is operated with respect to the particular conditions existing in each unit. The air supply to each boiler is maintained with respect to the thickness of fuel bed, so that the boiler furnace with thin fires will not get an excess of air over the adjoining boilers which may have thick fires.

This control also compensates for a blow hole condition existing in the various furances by cutting down the air supply, thus preventing the loss in furnace efficiency which would otherwise result.

Apparatus Used

IN connection with this system there is used: a positive pressure type blower for the furnishing of air to boiler furnaces; special type of steam damper regulator for operating the flue damper of each boiler;

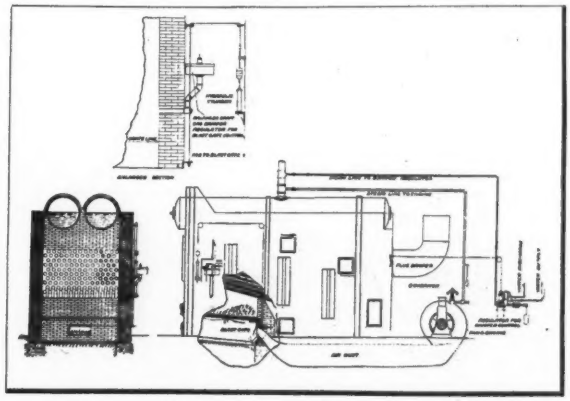


FIG. 2. DETAILS OF A BALANCED DRAFT CONTROL INSTALLATION

balanced draft gas damper controller connected for operating the blast gate in the ashpit of each boiler. The controller is shown in section in Fig. 3. The engine operating the blower is regulated by a ball governor, the blower running at approximately constant speed.

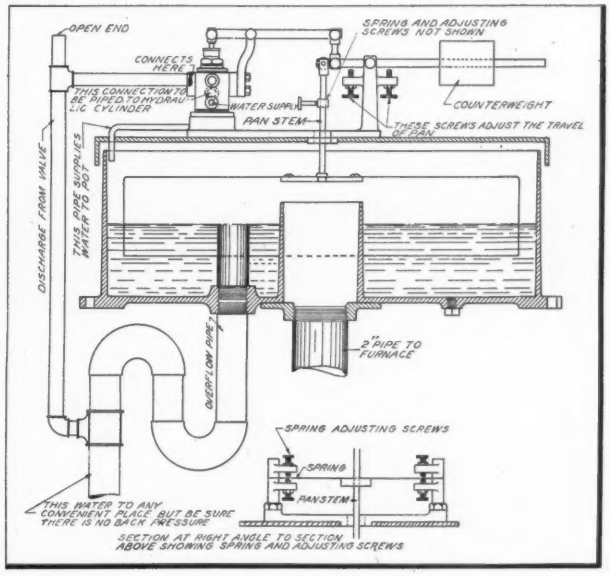

OPEN END
SPRING AND ADJUSTING SCREWS NOT SHOWN
CONNECTS HERE
THIS CONNECTION TO BE PIPED TO HYDRAULIC CYLINDER
WATER SUPPLY
PAN STEM
COUNTERWEIGHT
THESE SCREWS ADJUST THE TRAVEL OF PAN
DISCHARGE FROM VALVE
THIS PIPE SUPPLIES WATER TO BOILER
OVERFLOW PIPE
2" PIPE TO FURNACE
SPRING ADJUSTING SCREWS
SPRING
PAN STEM
THIS WATER TO ANY CONVENIENT PLACE BUT BE SURE THERE IS NO BACK PRESSURE
SECTION AT RIGHT ANGLE TO SECTION ABOVE SHOWING SPRING AND ADJUSTING SCREWS

FIG. 3. SECTIONAL VIEW OF GAS DAMPER REGULATOR

Blower delivers air to the main air duct at a constant pressure and volume. Assuming the working pressure of the boiler to be 100 lb. and the steam pressure to be dropping, the regulator for the damper control will immediately act, opening the flue damper

wider in each boiler. By such an action, a suction in the furnace chamber is immediately created, which acting on the gas damper controller opens the blast gate, admitting more air for the condition of increased combustion. With this method of operating, the various controllers are always in such a relation to one another that any predetermined pressure, or atmospheric pressure, may be maintained for all rates of combustion at the fire door.

The Engineer Company, Hudson Terminal Building, 50 Church Street, New York City, manufactures this system.

A REFILLABLE CARTRIDGE FUSE

AS the advantages of the enclosed or cartridge type of fuse are appreciated, this form is coming largely into all plants. The only difficulty encountered is that a cartridge cannot be refilled after it has once blown out, and sometimes, the exact size and capacity of cartridge needed is not in stock.

A convenient form of refillable enclosed fuse has been devised by A. F. Daum Co., Pittsburgh, and is now on

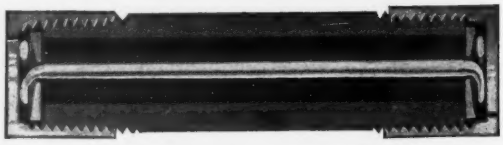


FIG. 1. DAUM FUSE CARTRIDGE FOR ROUND CLIPS

the market. The cartridge consists of a heavy fibrous shell on the ends of which are screwed heavy brass stampings, carefully machined. The fuse is a piece of ordinary fuse wire which is put through and the end bent against the contact at the end of the shell body and held by the

FIG. 2. DAUM CARTRIDGE FOR FLAT SPRING CLIPS WITH ONE SCREW CAP REMOVED

brass screw cap thus giving a compact enclosed fuse which fits readily into the ordinary type of enclosed fuse cutout block.

If the fuse blows at any time, it is a simple matter to insert a new piece of wire, turn the ends over, and screw on the brass ends of the cartridge, which will give an enclosed fuse as good as new. The Daum cartridges are made either for use with the round clips or the flat ends for the old style clips as may be desired.

NEWS NOTES

E. M. ADAMS, of Akron, O., president of the Ohio Society of Mechanical, Electrical and Steam Engineers, which is scheduled to hold its spring meeting in Pittsburgh on May 16, 17 and 18, was in that city recently to complete arrangements for the coming sessions. The meeting will bring together more than 150 Ohio engineers to Pittsburgh. Co-operation of the engineering bodies of Pittsburgh is being secured in the entertainment program. F. E. Sanborn, of the Ohio State University, Columbus, O., is secretary of the society. The local entertainment committee consists of A. A. Anderson, Standard Underground Cable Co.; A. W. Dodds, Pittsburgh representative of the Lunkenheimer Co.; J. E. Whittlesby, local agent of the Heine Boiler Co., and W. R. McCord, editor of the "Industrial World."

MASSACHUSETTS ASS'N No. 20 of the N. A. S. E. was the recipient of a very useful present at its meeting, Feb. 22, when the manufacturers of the city of Fitchburg gave it a present of an American-Thompson out side spring indicator, reducing motion, planimeter, and 5 extra springs for different pressures, enclosed in a handsome mahogany box with plate engraved: "To the Fitchburg Association of Stationary Engineers, No. 20. From their employers." One of Thomas Prey's instruction books, "Twenty Years with the Indicator," was included with the outfit. A vote of thanks was given the donors.

EXHAUSTION OF THE POTASH supply has been one of the worries of agriculture as on this supply depends the proper fertilization of soils. By search of the Bureau of Soils of the Department of Agriculture and the Geological Survey, a deposit of apparently great importance has been made at Borax Lake in California, the supply is estimated at over four million tons, enough to last the entire country for 20 years at the present rate of consumption.

FAVORABLE NEWS from the American Steam Gauge & Valve Mfg. Co. reaches us in regard to its annual meeting just held. At this meeting the usual annual dividend of 7 per cent was declared on both preferred and common stock, and report was made that while 1911 showed a usual normal increase in business, the business for 1912 is without precedent in the entire 63 years of the company's existence. Up to date 50 per cent increase is shown over the orders for the same period of 1911 and the factory is now working over time with increased capacity in every department, particularly that where gages are manufactured. This department will shortly be turning out over 1,000 American steam gages per day. This business comes from every section of the country, which gives every indication of a demand for high grade steam aparatus steadily increasing. It is encouraging to have from a representative concern such a report in this year when politics is popularly supposed to disturb general business and it is a good indication that the conditions in the power plant business world are in good shape and steadily improving.

CATALOG NOTES

GENERAL ELECTRIC COMPANY has just issued several attractive publications, one being devoted to electric heating and cooking appliances and their application to the home, office and factory. This bulletin, No. 4921, is printed in two colors on heavy coated stock, and has an attractively embossed cover. Many of the various devices are shown in use.

Bulletin No. 4929 is devoted to the application of electric motors to the operation of brick plants. In this bulletin is shown the electric motor as used in the various operations of brick manufacture.

Commercial searchlight projectors is the subject of Bulletin No. 4928. This bulletin describes not only the carbon arc projectors, for which this company is noted, but contains also illustrations and description of the incandescent lamp searchlights just placed upon the market.

General Electric Company's latest development of the commutating pole motor, known as Type DLC is described in Bulletin No. 4940.

BUREAU OF MANUFACTURES now has in press a bulletin that will no doubt find a permanent place on the desk of every manufacturer interested in foreign trade. In its 56 pages will be found answers to questions asked by every manufacturer sending out trade literature

or opening correspondence with foreign firms. What language is it best to use? In what currency and what weights and measures should prices be quoted? What postage should be placed on the catalog or the letter? Can I prepay a reply from the prospective customer? Is there a parcels post. The bulletin answers these and other questions for each country in a concise manner. Supplementing these statements are tables for converting the money of foreign countries into that of the United States; also a comparison of prices for countries in which both the monetary unit and the units of weight and measure differ from those used in the United States. Currency conversion tables and price comparisons are given for over 30 countries. Foreign postage rates and the parcels-post regulations are summarized, and a list is given of the countries in which international reply coupons are valid. Copies of the bulletin which is entitled "Factors in Foreign Trade" will be available for distribution at an early date, and those desiring it should make application to the Bureau of Manufactures, Department of Commerce and Labor.

BULLETIN OF ENGINEERING RESEARCH No. 101, entitled "Lamp Efficiency," issued February 1, 1912, by the Engineering Department of the National Electric Lamp Association, discusses the factors involved in the operation of incandescent lamps for a minimum cost of light. An analysis of the cost of light, factors controlling the cost of light (cost of energy and cost of lamps), the determination of the operating conditions under which a given type and size of lamp will produce light most economically and the approximate method of computing the best efficiency are given a detailed treatment. The subject is taken up in an analytical method and illustrated by a large number of curves showing lamp performance.

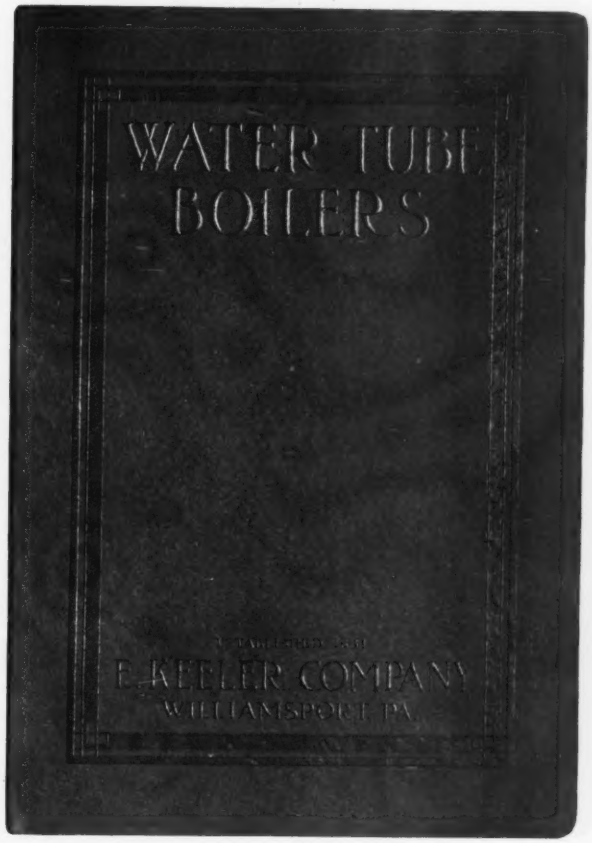
TERRY SERVICE is the title of an attractive and well illustrated booklet just brought out by The Terry Steam Turbine Co. It shows the wide range of uses of the thousand Terry Turbines now in use in all parts of the world, driving generators, pumps, forced draft and gas blowers, etc. It also gives the names of prominent installations and is striking evidence of the increasing use of small steam turbines in various industries. This booklet will be sent on request addressed to The Terry Steam Turbine Co., 90 West St., New York.

CATALOG B ISSUED by the Kelly Foundry & Machine Co., of Goshen, Ind., describes a new form of shaking, rocking and dumping grate with the particular feature of a rear grate section which has especially large capacity for letting clinker formation into the ash pit. The catalog explains in detail the construction of these grates and shows the arrangement and different combinations.

A PAMPHLET ENTITLED Information No. 2 on the subject of Bakelite is issued by the General Bakelite Co., of 100 William St., New York. This tells what Bakelite is, its use for varnishes and lacquers, its adaptation to protective enamels, adhesive cement and moulded articles and its use for electrical purposes and as an insulator against electric voltage and the action of the weather. At the end of the booklet are shown some of the numerous articles made of this substance ranging from a washer to a dynamo brush holder.

INGERSOLL-RAND CO., 11 Broadway, New York City. Buletin form 4204, 16 6 by 9 pages, descriptive of Arc Valve Tappet Rock Drills. These drills have an arc shaped valve which is moved on a circular seat by a rocking tappet, the sliding surfaces all being concentric with the rocker pin. The working pressure is on the back of the valve, forcing it to its seat, so that wear, instead of inducing leakage, only improves the tightness of the working valve parts. The valve is moved by the piston through an intermediate tappet or rocker. This tappet swings on a pin and extends slightly into the cylinder bore, where it is moved by beveled shoulders on the piston sliding under it. An arm on the tappet carries a spring and plunger engaging the valve. The function of the spring is to hold the valve to its seat when there is no pressure on the drill. This arrangement of spring and plunger also acts as a relief valve in discharging water of condensenation which may collect in the cylinder when steam is used. Catalog shows duplicate parts of drill, also sectional views, and gives descriptive table of sizes and capacities.

WATER-TUBE BOILERS are an important part of the equipment of a modern power plant. The subject is one which needs to be studied carefully because of the intricacy and the varying features of the different types. Those who wish to be fully posted on this subject will find the book entitled "Water-Tube Boilers," published by E. Keeler Co., Williamsport, Pa., an interesting and



valuable piece of literature as well as most attractive and desirable to have in one's library. The book shows in large instructive drawings the details of construction and equipment of the different types, methods of suspension, construction of fire doors, arches and casings and other special details for convenience of operation. It discusses also the requirements of a modern steam plant, and illustrates a number of plants containing the Keeler boilers.

"GOVERNOR UPKEEP—Why Have Any?" is the title of a 4-page folder just issued by A. L. Ide & Sons. The body of this folder is a reprint of an article published in Practical Engineer and supplementing this article are given reasons why the Ideal Armstrong governor gives none of the troubles described in the article. The folder may be had by writing A. L. Ide & Sons at Springfield, Ill.

STARTING CURRENTS OF TRANSFORMERS, with special reference to transformers with silicon steel cores, by Trygve D. Yensen, has just been issued as Bulletin No. 55 of the Engineering Experiment Station of the University of Illinois. The transformer has come to be regarded as one of the most reliable and simple pieces of electrical apparatus. As new material, however, is utilized to increase its efficiency, new problems arise. One of these problems is the momentary rush of current that occurs upon closing the primary circuit of a transformer. In Bulletin No. 55, it is shown that while this starting current for old type transformers may rise as high as 4 times full load current, it may rise to more than 7 times full load current for the new type with silicon steel cores. The phenomenon is fully explained and illustrated by means of oscillograms.

Copies of Bulletin No. 55 may be obtained upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

FOLDERS RECENTLY RECEIVED from the H. W. Johns-Manville Co., are as follows: Safety Blow-off Sectional Pipe Covering, J-M High Temperature and Acid-Proof Cements, More Steam with ⅓ Less Coal, J-M Permanite Sheet Packing, J-M Asbesto-Sponge Felded pipe covering.

STEAM TABLES FOR CONDENSER WORK is the title of a hand book of steam tables with pressures below atmosphere expressed in inches of mercury referred to a 30-in. barometer; also including a discussion of the use of the mercury column, the errors in such measurements and constants for their correction. In this country, the standard generally accepted for measuring pressures below atmosphere is vacuum in inches of mercury referred to a 30-in. barometer. Ordinary steam tables, however, do not give pressures in vacuums, and there is no generally accepted standard of the properties of steam at say, 28 or 28.5 or 29 in. vacuum, or of just exactly what pressure is represented by any given vacuum referred to a 30-in. barometer. It is with these points in mind that the publication "Steam Tables for Condenser Work," just issued by the Wheeler Condenser & Engineering Company, of Carteret, N. J., has been prepared.

The principal features of the book are 3 steam tables. In the first table the independent variable is vacuum, and the properties of saturated steam are given from 29.8 in. vacuum up to atmospheric pressure. In table 2, the properties of steam below atmospheric pressure are given from 32 to 212 deg. F., the temperature being the independent variable accompanied by the pressure expressed in vacuum in inches of mercury referred to a 30-inch barometer and also expressed in pounds per square inch and inches of mercury absolute pressure together with other properties of steam. Table 3 gives the properties of saturated steam from zero to 200 lb. gage, the independent variable being gage pressure instead of absolute pressure as usually given.

Following these steam tables several pages are devoted to a discussion of the principle of the mercury column and barometer. This hand book, which represents a considerable expenditure in time and money, is published by the Wheeler Condenser & Engineering Co., Carteret, N. J., primarily for the assistance of engineers using and purchasing condensers and condensing apparatus, to whom it will be sent upon request. Copies are not for sale or general distribution.

TRADE NOTES

OWING TO THE INCREASED volume of export business which has been received by the American Steam Gauge and Valve Manufacturing Co. of late, it has been necessary for Mr. Gardner Cornett, Vice President and Manager of the New York office of this company, to take an extended trip through England with particular reference to the railroad and ship building interests, which American products have appealed to. This company reports more active foreign interest in its products during the last 6 months than it has ever before known. Also that its present business has so increased in every department that beginning the first of April night work was started,—a pleasing indication of the renewed activity that everybody has been prophesying in the industrial world for the last 2 years.

SATISFACTORY LUBRICATION FOR wheels of cars used in mines has long been a difficult problem to mine owners. There are probably 40 different devices for keeping grease or oil on the axles of mine cars. The Keystone Lubricating Co. has been studying this problem for some time and has accomplished results that have pleased mine owners and workers. A large and constantly increasing number of mines are now using Keystone Grease. Reports from these mines show that the grease performs its work for a practically indefinite time and without renewal. Many of the axles remain undisturbed for 6 months, a year and even longer.

A NEW BURY Variable Volume air compressor has recently been installed for the Erie Malleable Iron Co. After a trial run of 1 hr. the compressor was thrown on with full load, since which time it has been running continuously. This type of machine has been built to meet varying load conditions and reduce the peak load to a minimum.

TO TAKE CARE of the increased demand for special investigations of problems pertaining to scientific lubrication, the Richardson-Phenix Co., lubrication engineers and manufacturers, Milwaukee, Wis., announce that Mr. C. Lee Straub has recently been placed in charge of this department, making his headquarters at the New York office, Hudson Terminal Building.

Mr. Straub is a graduate of the Lehigh University and has had a broad experence on large engineering enterprises. He was for some time connected with the Bethlehem Steel Company and later was in charge of the Producer Gas and Engine Department of the Power & Mining Machinery Co., and for the past few years has been engaged in consulting engineering.

Mr. Straub is well fitted to make special investigations of all problems concerning scientific and economical lubrication of power plant machinery, transmission machinery, machine tools, etc.

Any installation necessitating unusual equipment or design of special lubricating apparatus will be given his special attention.

This service of advising on the solution of lubricating problems is furnished free to its customers and clients by the Richardson-Phenix Co.

Sparks From The Advertising Pages

It has been said that one way in which to acquire an engineering education is to study the advertisements found in technical papers. But there are few who realize the extent to which an engineer may better himself by keeping in close touch with the information which is furnished by the advertisers.

In speaking of this phase of the matter, Mr. Charles J. Mason, of Scranton, Pa., says:

"As a matter of fact, the advertisements, taken as a whole, are better educators in that new and important branch of engineering known as "commercial engineering" than are the ordinary text-books. Text-books deal with elementary principles and lead up to the application of those principles to practical everyday use. They have an important place in the education and training of the engineer and undoubtedly will always be needed. *But they do not, nor can they, teach the dollars and cents features embraced in commercial engineering, which is so important to the engineer who aspires to become chief of something worth while.*

"It is well known that in these days a chief engineer must be something more than a good mechanician and a scholar in the science of steam engineering and an expert in the handling of men and machines; *he must know something of the commercial aspect of the business.* And, as I said before, one of the ways to become familiar with that branch of knowledge is to study—not merely read—the advertisements which appear in every issue.

"They tell of something that has been found out by experiment and experience—something that somebody has spent time and thought upon—and they tell it in the few terse sentences which make up the advertisement.

"Let me give a few brief examples of what may be gathered from the advertisements in regard to starting a line of thought along commercial engineering. First, I will refer to the Kerr Turbine Company's advertisement on page 111 of the February 1st issue of Practical Engineer. In the second paragraph it refers to 'reciprocating engines are built for one economical load only' and 'the variation of load makes this difference in a Kerr turbine.'

"How many engineers are there who know that it is a fact that there is comparatively narrow range of load at which economy is the highest in a reciprocating engine? How many know why this is so? The people who caused the advertisement to be written know that the statements made are facts, because they have investigated and have experimented and proven the things to be as they say. Is there not a broad hint here for the reader of the advertisement to inquire as to the why of things? Should he not want to be in a position to be able to answer in a positive manner the statements referred to? I think so.

"On page 112 of the same issue, the American Engine Company's advertisement says 'steam is worth from 10 to 20 cents per 1000 pounds.' Continuing it shows how an investment of an extra thousand or two dollars on the first cost of an engine will pay in the end. It is a fact. It has been investigated and tried out and is beyond the experimental stage. It is now merely a matter of simple arithmetic. But how many engineers could do as signified in that ad? How many know how much 1000 pounds of steam costs in their own plants and know how to arrive at the cost? The inquisitive reader will want to know about these things and the advertisement has given him a starting point from which to work.

"Finally I turn to page 113 and read the Ingersoll-Rand Company's advertisement. Here I find a capital hint on *cost analysis* . . . a clue is given as to how to go about cost analysis, which is part of commercial engineering, and which an engineer must know if he desires a full measure of success in his calling.

"The thinking man will, upon reading such advertisements, get out his pencil and pad and get busy on things about his own plant. He will then be on the road to learn what economy means and how it may be obtained. Read the ad's—they are worth the time in more ways than one."

Mr. Mason has brought out the educative value of studying the advertising pages in a way so clear as to need little emphasis. There is scarcely an issue that does not contain advertisements from which most any engineer could derive help. We were glad to hear from Mr. Mason upon this subject and we would be glad to hear the experiences and opinions of others.

A MILD BUT EXPLICIT protest from the engine room to the office comes to hand to prove that a saving sense of humor under trying circumstances may well be useful to the autocrat of the power plant.

Mr. Stuart Cooper,

Purchasing Agent.

Dear Sir:—

I take my pencil in hand to write you a few words touchin' on an' appertainin' to E-jectors and their cousins, once removed, In-jectors. Exhibit A is a true likeness of E-jector, vouched for by Pro-jector, Hayden and Derby (Pronounced Dar-bee.)

EXHIBIT A. THE H. D. EJECTOR, MODEL C

Working on the basis of the old axiom that "A Rose Would Smell as Sweet by Any Other Name" we would admit that placing Exhibit B in a box labeled Exhibit A would not make Exhibit B, Exhibit A. In this matter of fact period of the earth's progress when the human mind has E-jected the pall of superstition, when men marvel at the mentalities responsible for

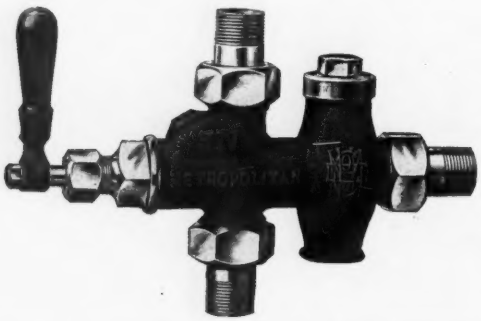


EXHIBIT B. AUTHENTIC LIKENESS OF THE METROPOLITAN INJECTOR, MODEL N

the Salem Witchcraft, of the Inquisition of Torquemada, of the inhuman Cortez, we do not look for nor even think of superstitional phenomena, such as having an E-jector transformed into an In-jector in transit. To err is human, to forgive divine; permit us to mount the "empirical" heights of divinity in extending our heartfelt forgiveness to the Price Hardware Co., of Pulaski, and for goodness sake get us some E-jectors for we need 'em BAD. J. M. S.

• THAT CANADIAN CITIES appreciate the value of modern automatic water-controlling valves is indicated by orders recently received by the Golden-Anderson Valve Specialty Company, Pittsburgh. These orders include several 8-in. and 10-in. automatic water-controlling altitude valves, for automatically maintaining uniform water level in standpipes and reservoirs. From the same source was received an order for a number of 12-in. and 24-in. water pressure regulating valves.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—As engineer in New England. Six years on Corliss and high speed engines. Used to electricity and heating. Good references. No bad habits. Age 32. Address Box 218, care of Practical Engineer, Chicago,

POSITION WANTED—By engineer with second class Massachusetts license and 15 years experience on compound and simple engines. Can do general repairs. First class references. Position preferred in Springfield, Mass., or Providence, R. I., but would accept in Conn. or New York State. Address Box 216, Practical Engineer, Chicago, Ill. 4-15-1

POSITION WANTED—As engineer in small plant or electrical or steam assistant in large plant. Have had experience with high speed engines, boilers, pumps, A. C. and D. C. machines, meters, line work, etc. At present employed. Address Box 217, Practical Engineer, Chicago, Ill. 4-15-1

POSITION WANTED—As engineer by man 30 years of age. Have had 5 years experience with Corliss and High Speed engines, alternating and direct current dynamos, boilers and pumps. Can show first class references. Apply C. J. H., care of Rev. Jos. Sunter, Stonechurch, Le Roy, N. Y. 4-15-1

POSITION WANTED—By young married man as electrician in small plant. At present employed by the largest power station in the west. Address Box 220, care of Practical Engineer, Chicago, Ill. 4-15-1

Wanted

WANTED—EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one and two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. t.f.

WANTED—THOROUGHLY COMPETENT experienced mechanical rubber salesman for the city of Chicago. Must have an acquaintance amongst the large buying trade. State age and experience, also give references. Address Box 814, Trenton, N. J. 4-1-2

Patents and Patent Attorneys

PATENTS—C. L. Parker, Attorney-at-law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill building, Washington, D. C. t.f.

Miscellaneous

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write to-day. M. Y. C., 1413 W. Jackson Blvd., Chicago, Ill.

AGENTS WANTED—WE WANT a live-wire agent, either engineer or specialty salesman in every town to furnish lists of names and take orders for Akron Metal Gaskets, the most complete line of metal gaskets made. Write for our proposition. Akron Metallic Gasket Company, Dept. PE., Akron, Ohio. 4-15-1

For Sale

FOR SALE—SET OF PRACTICAL Engineering Books—3 vol. Cost $12.00 will sell for $6.00—good as new. Also new set of Hawkins' Library—7 vol. cost $10.00—will sell for $5.00. Both sets to one party for $10.00. A 5 volume set of The Practical Reference Encyclopedia, cost $18.00. Will sell for $9.00. All three sets only $18.00. Address Box 219, care Practical Engineer, Chicago, Ill. 4-15-1